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SILICON CHIP

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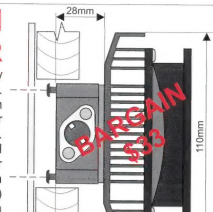

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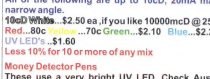

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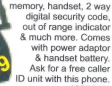

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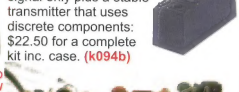

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Contents

Vol.15, No.12; December 2002

SILICON CHIP

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FEATURES

7 Receiving TV From International Satellites
With the right gear, you too can watch international satellite TV. Here's a look at what's required & the programs available – by Garry Cratt

53 The Hong Kong Trade Show Report
An enormous show with over 2600 exhibitors – by Leo Simpson

66 Review: GW Instek GRS-6032 Digital Storage Scope
Interesting design combines a 30MHz dual-trace analog CRT readout with digital storage – by Leo Simpson

PROJECTS TO BUILD

18 The Micromitter Stereo FM Transmitter
At last! – a stereo FM transmitter that's a snack to align – by John Clarke

32 A Windows-Based EPROM Programmer; Pt.2
Second article gives the full assembly details & describes how to check the programmer's basic hardware operation – by Jim Rowe

40 Build The Decision Maker
Can't make up your mind? Build this simple unit for an emphatic answer when ever indecision strikes – by Trent Jackson & Ross Tester

68 SuperCharger For NiCd & NiMH Batteries; Pt.2
Completing construction and learning how to drive the new SuperCharger. There's also a handy table of beep error codes – by Peter Smith

86 Simple VHF FM/AM Radio
Looking for an ideal first project? Try your hand at this simple radio – by Andrew Woodfield

SPECIAL COLUMNS

28 Circuit Notebook
(1) Traffic Lights For Model Cars Or Railways; (2) LED Torch Uses Blocking Oscillator; (3) AFX Slot Car Lap Counter; (4) Simple BFO Metal Locator; (5) Capacitor Leakage Adapter For DMMs; (6) Simple AM Radio Receiver.

54 Serviceman's Log
A shame about the Shamrock – by the TV Serviceman

78 Vintage Radio
Intermediate Frequency (IF) Amplifiers; Pt.1 – by Rodney Champness

COMPUTERS

60 Using Linux To Share An Optus Cable Modem; Pt.2
Installing a name server (DNS) & a DHCP server – by John Bagster

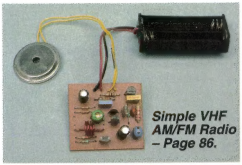
DEPARTMENTS

2 Publisher's Letter
4 Mailbag
59 Silicon Chip Weblink
91 Ask Silicon Chip
93 Notes & Errata
94 Market Centre
96 Advertising Index

Receiving TV From International Satellites – Page 7.

Micromitter Stereo FM Transmitter– Page 18.

Make Up your Mind: Build The Decision Maker – Page 40.



Simple VHF AM/FM Radio – Page 86.

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PUBLISHER'S LETTER

CRT video monitors have had their day

A few months ago I wrote that the VCR was coming to the end of its life cycle, not only because VCRs are very cheap but DVD players are also coming down in price. And while DVD burners, the ultimate replacement for VCRs, are still not cheap, they are starting to come down too.

Now it is becoming clear that CRT video monitors for PCs are on the way out too, being rapidly replaced by LCD monitors. In this case, the price parameters are a little different. CRT (cathode ray tube) monitors have not drastically reduced in price but LCD monitors have done so, and so large numbers of companies and public institutions are re-equipping with LCD and to a lesser extent, plasma monitors. If you need any evidence, drop into your local supermarket, insurance company office, court house, library or virtually any large public company or government institution – they are buying LCD and plasma monitors by the thousands.

Apart from the price factor, you can readily understand why CRT monitors are falling out of favour. LCD monitors take up far less desk space, use less power, are much lighter to move around, have no flicker and do not present any latent hazards such as exposure to X-rays or intense magnetic fields (from the CRT sweep circuitry). In the longer term, LCD monitors are bound to be more reliable and much less of a fire hazard because they do not contain high-voltage drive circuitry.

It is true that the ultimate screen resolution of LCD monitors is not quite as good as the best of the larger CRT monitors but in practice that does not seem to matter for most applications. And there is a further benefit in that the viewable area of LCD monitors is greater than CRT monitors with the same nominal diagonal measurement.

Actually, we suspect that the real reason why so many organisations are changing over to LCD monitors has little to do with the factors listed above; it is just because they look "cool". Mind you, I think that in our own office at SILICON CHIP we won't buy another CRT monitor either, but of course we are not likely to be motivated by the fashion aspects (serious nodding all round, I see).

Seriously, for those organisations who persist in running their computers 24 hours a day, often without power saving monitors, the changeover to LCD monitors will lead to major energy savings and for that reason they will represent a worthwhile investment.

For domestic users, the situation is not so clear cut. Typical PC video monitors seldom wear out when they are not left on for long periods every day. Nor is energy use a major factor. Unless you are well-heeled and can cope with the price of a new LCD monitor, you will probably have to make do with your present computer monitor for some time to come. But if you use a computer with a CRT monitor at work, you can console yourself with the thought that the monitor's days are numbered and that sooner or later you will have a snazzy new LCD monitor.

Leo Simpson

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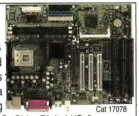
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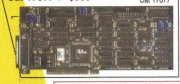
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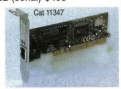
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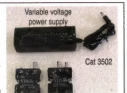

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MAILBAG

Data needed for Sanken amplifier module

Some years ago, I purchased some Sanken SI-1030G hybrid amplifier modules from David Reid Electronics. I built the amps but never actually used them. Now I do have a use for them. When I moved house two years ago, I discarded a lot of my old electronics documents and calalogs and inadvertently threw away the data on the amp modules.

I've contacted David Reid but they're not able to help me out. I've visited the Sanken website in Japan. The product is listed but identified as discontinued and Sanken do not have a contact email address listed on their site

I'm hoping that some SILICON CHIP readers may be able to help me out with any data they may have tucked away. I'm primarily after the DC power rail voltage for this particular amplifier. I think it was 44V.

I know the 1982 David Reid catalog (plus or minus a year) contained the data and that's the document I discarded.

Mal Land,
intelectsol@hotmail.com

Data logging of speeding vehicles

We have speeding vehicles and noisy vehicles in our suburban back street. The biggest problem is convincing the police/transport department that we have a problem. Could I suggest an electronics project that might be able to detect a vehicle's speed and noise level with the capability of logging the data into a computer?

I am sure many readers of SILICON CHIP probably have the same problem.

Neil Bruce,
via email.

LED circuit overkill

On page 27 of the October issue there is a very wild bit of circuitry for a triple-LED version of a torch. Perhaps I am missing something because I cannot see the necessity for all this. Recently, I modified a flanged torch globe base to accommodate high-intensity white LEDs of 3mm diameter. These cost only $3.95 each and the light is quite adequate for my purposes.

I located the LEDs so as to preserve the focus of the reflector as near as possible. The light is white and is blindingly bright when viewed from the front. The best part of this is that the current is only 25mA. So I expect the battery, (two AA cells) to last a very long time.

John Gillard,
Cleveland, Qld.

Comment: if you are powering white LEDs from two AA cells the brightness will be far below what can be obtained at around 3.5V. There is a huge difference. If you don't believe it, try using three AA cells and feed each LED via a 47Ω resistor. The step-up circuit on page 27 of the October issue has the advantage that you get constant high brightness even as the cells go quite flat, giving long battery life.

Ignition switched via accessory line

I am writing in reference to "Cranking Difficulties with Austin A1300", on page 91 of the October 2002 issue. As a hint, it sounds as though he has the ignition project powered from the accessories line (which is switched off during starting). After all, he does state that "the engine will run once the ignition switch is released to the running position".

Tim Griffiths,
Waratah, NSW.

Comment: Yes, we should have picked up on this – we have been through this with other readers many times before.

RF projects should be available

One of your letters in the October issue suggested that more projects along the lines of RF and amateur radio should be included. I would agree with that.

A large proportion of the circuits I design and build for fun are RF-related, mainly simple VHF FM receiver circuits with as few valves or transistors as possible. (These days the program content of AM stations makes receivers for that band rather useless, except as a novelty, in my opinion).

For example, I built a 6-transistor super-regenerative receiver for listening to FM stations 10 years ago. I have been using it on my daily train trip to work and back ever since. I have also recently designed and built a miniature valve FM receiver using only a 12AT7. It drives headphones to an almost uncomfortably loud level. Crystal sets can also be made to work on FM.

Another favourite FM reception technique is that of using a pulse counting detector. This allows a simple resistance-coupled IF strip operating at about 200kHz.

I have often considered submitting these types of designs for your Circuit Notebook section but don't get the impression valve circuits or receivers that aren't stereo with .001% distortion are what your magazine likes to promote.

As for further ideas for projects, I think a lot of the designs from ETI and EA from the 1970s and 1980s could be brought up to date and redone, using modern components as well as perhaps fixing the design faults a few of these projects had. One particular project of interest was done by ETI to control a soldering iron by measuring the resistance of the heating element. This meant that any old 240V soldering iron could be used with no mods. I'm interested in adapting this for electric blanket control.

To end on the topic of nanofarads, I can see the necessity for change and

although I have never used that unit of capacitance for my own work, mentally converting nF to µF is second nature as I read the circuit diagram.

John Hunter,
via email.

Comment: as far as valve circuits are concerned, it is true that we have a policy not to publish - after all, the magazine's title is "SILICON CHIP". However, we have nothing against RF or receiver circuits and we have a simple VHF FM/AM receiver featuring slope detection in this issue. If you have circuits of interest, please send them in.

Test equipment manuals wanted

Could you please ask your readers if (a) a circuit and manual could be bought or copied for a BWD 845 storage scope; (b) my old faithful BWD 509 had an accident and needs another tube, 5UPI(f); and (c) I also need a manual for a Topward 7046, 40MHz scope.

Graeme Muir,
PO Box 15,
South Morang, Vic 3752.
Phone (03) 9436 9100.

Keen reader endorsement

We've really enjoyed getting SILICON CHIP delivered regularly. While we've been buying it for years, it was disappointing the times it had already been sold from the newsstand or we just couldn't find a newsagency who carried it. We're a bit more settled now and will be renewing our subscription regularly.

You put out a thoroughly engrossing magazine and our back issues are as useful as the current ones. We've just built an infrared PC transceiver from the December 2001 issue after adding a little laptop to the PC menagerie. It's just the ticket for transferring files to and from the newcomer.

We particularly like the straightforward nature of SILICON CHIP, your readable articles, intelligent letters, pertinent ads (we both enjoy reading the ads and finding stuff to order), and your response to any issues raised.

Thanks for a terrific read each month.

Stuart Mullan & Eden Clarke,
Fingal, Tas.

Qualified reader endorsement

I read with joy the letter from Mr Wilson in the October 2002 issue and I agree with him fully. I will be frank. I subscribe to your magazine because it is the only one left in electronics not because I enjoy all of it.

I subscribed to EA for many years and I was a contributor to it about 1988. Under Jim Rowe, it was a very good magazine until it self destructed when it changed format. I miss the Radio magazine with its very interesting articles on all aspects of communication.

A few months ago NOAA launched a new weather satellite which is giving wonderful pictures in the visual and infrared bands. It passes overhead every morning where I live west of Brisbane and I get coverage from Tasmania up to beyond New Guinea. On 12th September, 2002, India successfully launched its first geostationary weather satellite. We need a magazine that keeps us up to date with satellites.

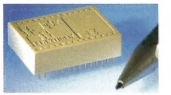
And scanners: I have an AR1500 scanner which goes up to 1.2GHz. I monitor the command centre for the fire service in SE Queensland. I monitor charter air services and the Ipswich Police and surrounds, including my town. Radio-mag used to give what they called "hot frequencies" for scanner users.

We need some of that. I am isolated here but communicate using Packet with Ipswich via a Digipeater on a hill. There, there is a TeleText service bulletin board which I can use and also collect messages from a Digital club I belong to in Brisbane but never have visited.

I want an electronics magazine that gives me "information" about what is happening in that world; news about space, satellites – commercial and amateur; what is going on in the radio world. What weird or funny stations are broadcasting and what they broadcast. What frequencies are the ambulances, rescue helicopters, etc using?

Finally, a comment on the Publisher's Letter. I do wish you would use your Editorial to talk about electronics. The one in October is bad. You rave, and I mean rave, on about what a wonderful world it is now. I preferred the one 30 years ago.

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

Intelligent RS232 to RS485 Converter

The JED 995X is an opto-isolated standards converter for 2/4 wire RS422/485 networks. It has a built-in microprocessor controlling TX-ON, fixing Windows timing problems of PCs using RTS line control. Several models available, inc. a new DIN rail mounting unit. JED995X: $160+gst.
Www.jedmicro.com.au/RS485.htm

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.
Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5488
www.jedmicro.com.au

Mailbag: continued

Now please do something about the extra articles as it is the only magazine that represents us, the technical readers hungry for news. I enjoy some of the magazine very much.

Doug Thwaites,
Esk, Qld.

Amateur radio articles not wanted

Having forgotten to respond to the letter from G. J. Wilson in the October 2002 issue, I was reminded by the letter of support from P. Dawson in the November 2002 issue.

Please don't change the magazine's format to include Amateur Radio articles. While I have an interest in RF engineering and projects like remote controls, 2.4GHz wireless, wireless video/audio, mobile phones, AM/FM radio trainers, model R/C, VHF/UHF & satellite TV, and VHF 433MHz portables, I'd rather not see articles on Shortwave, DX-ing, RFDS, NDB, marine and HF frequencies etc, in SILICON CHIP.

The very occasional article on Ham Radio would be more than enough. I believe there are other mags that cater for Ham Radio, although they may not be Australian. As you can tell from my lack of knowledge on those mags, I am not interested enough to spend much time browsing them in the newsagent, hence I don't want to see their content in SILICON CHIP.

EA was at least along the same lines as SILICON CHIP, apart from the latter years, and while I used to buy the odd EA if it looked interesting, I subscribed to SC, because it was always interesting, even if I didn't build anything from the issue.

David Boyes,
via email.

Solar panels have low output

Ben Haszard's letter (SILICON CHIP, November 2002) ignores a fundamental point. In my opinion, the best legacy we can leave to future generations is a society which encourages an inquiring mind and the development of individuals to their full potential and NOT "non-renewable natural" resources. To this end, SILICON CHIP performs a useful function in our society by disseminating technological innovations and publishing projects which encourage skill development.

As to Ross Tester's article about solar power, I decided to conduct some "real world" experiments using an Amp-Hour meter in a 12V set up. The power delivered by two 48W solar cells was so low (well below specs) that I need to rethink my experimental set up. So, Ross' analysis seems to be optimistic and the real cost/benefit may well be significantly below his numbers.

Frank Winter Ph.D.,
via email.

ETI480 amplifier not a bad design

I am pleased to see that you have now got the copyright to all the ETI and EA articles. Have you been able to get the copyright for AEM? It had a few good projects also.

I now wish to take issue with your comments on the ETI480 on page 31 of the October 2002 issue. About 20 years ago the then IREE Brisbane Audio Group embarked on a project of 2-way satellite speakers coupled with a powered subwoofer and electronic crossover. After some analysis by some technically expert members we settled on the ETI480 as it was available, cheap, had adequate specs, was reasonably easy to build and had "been around for a while". My guess is that it was/is one of the longest enduring designs in kit form produced by a magazine in the last 25 or so years.

As a group activity we built many of these amplifiers. We had no trouble with any of them and I believe they are all still going, otherwise I feel I would have been contacted for assistance. We are totally bemused by your comments.

In fact, reading your piece about the ETI480 in October and your own statement that you now own the copyright to the articles, it seemed like a case of taking a belated opportunity to criticise a design by someone else which just happened to be very successful in the "kit marketplace".

You could have done that before October 2002 in a constructive manner and saved much angst by the students as well as using this as a springboard to an alternative design by SILICON CHIP.

I understand that the ETI480 has some technical shortcomings (don't they all?) but I am hopeful that you are not going to demean yourselves by using SILICON CHIP as a forum to take a lot of cheap shots at other designs by now non-existent magazines.

Keep up the good work guys and don't change the format.

Ranald Grant,
Brisbane, Qld.

Comment: the short article in the October issue about the ETI480 may have seemed like a cheap shot and a belated one at that but the truth is somewhat different. First, concerning your point that we could have attacked the amplifier years ago, it was not our policy to publicly denigrate the opposition magazines or their designs. However, behind the scenes in years past we have made the kitset suppliers aware of our concerns with regard to this amplifier.

Their response has generally been along the same lines as yours: the amplifier is cheap, has adequate specs and is very popular. It is this very popularity which has been very hard to counteract. And even though many people have got this amplifier module to run satisfactorily (ie, not blow up or evidently oscillate!), many more have had trouble with it.

In appreciation of SILICON CHIP

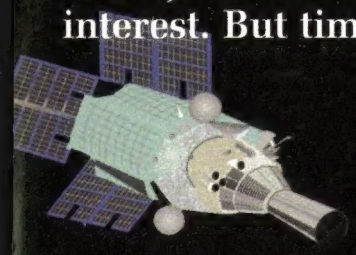
Yesterday afternoon I was having a quiet half-hour with October's edition of your magazine, reading and fathoming how each section of John Clarke's Speed Controller worked.

I came to electronics towards the end of the usual working life span and so find it all new with a fair bit of "black magic" involved. It occurred to me how much pleasure I was getting from the article, much like some people get doing crossword puzzles.

It also occurred to me that perhaps your group were not often made aware of the pleasure that readers experience reading SILICON CHIP. Thank you.

Name & address supplied but withheld at writer's request. SC

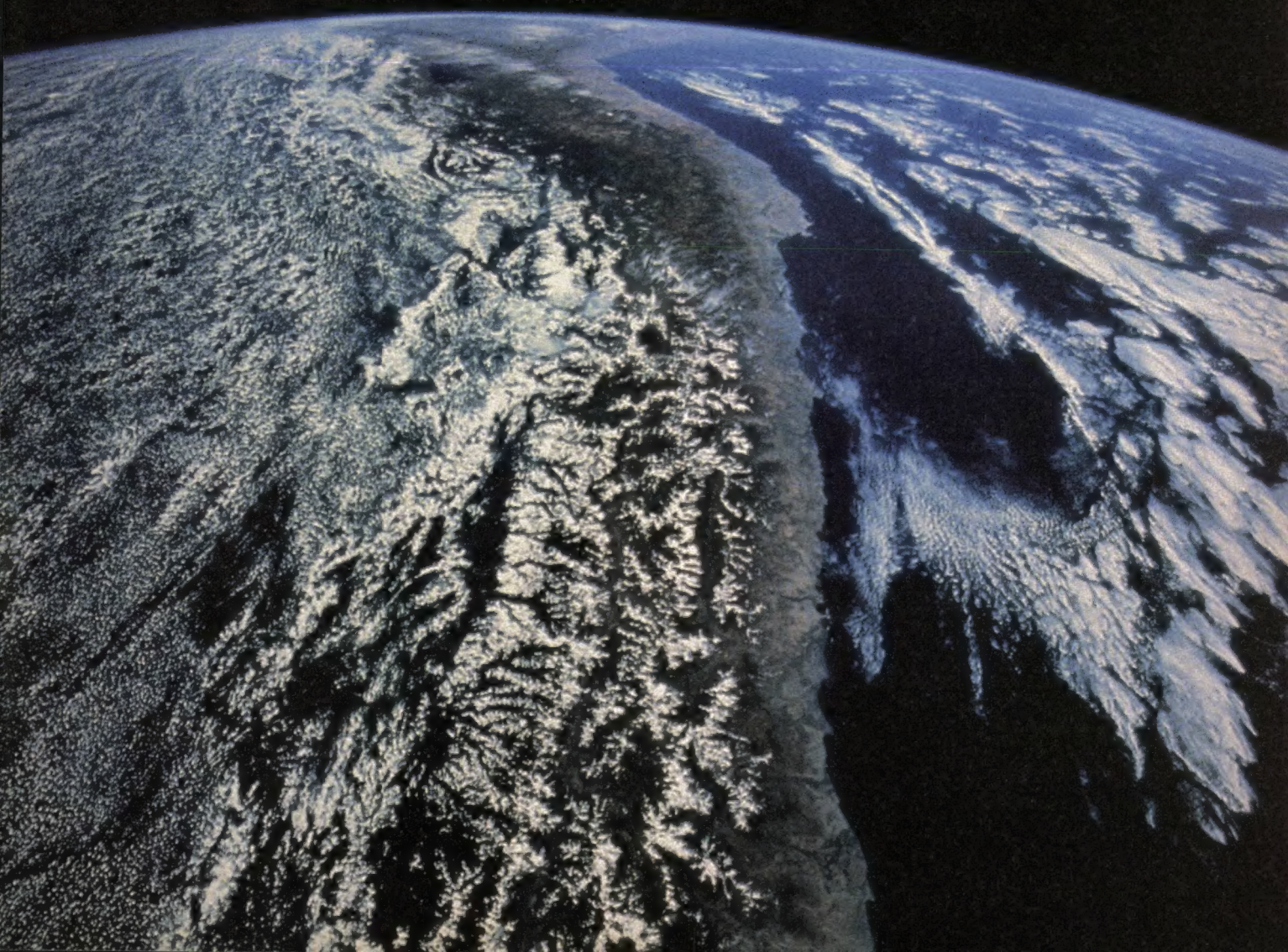
It has been quite a few years since we have described an up-to-date, free-to-air home satellite TV system. In fact the last time we covered the subject was in May 1995 and that article sparked a huge amount of interest. But times (and satellite TV) have changed in the last few years.



With the right gear, you too can watch

INTERNATIONAL SATELLITE TV

Part 1: by Garry Cratt*



Since 1995, more satellites have been launched, more free-to-air channels have become available and prices have dropped, hence our revitalised interest in the subject. And all this in the face of Pay TV which continues to have mixed success in Australia.

One of the significant technological improvements that has had a major affect on home satellite systems is the introduction of MPEG broadcasting. This is a form of digital compression that allows a huge improvement in the efficient use of the satellite spectrum.

As more channels can now be transmitted within a fixed bandwidth, the operating cost to broadcasters has decreased, making international satellite broadcasts an economical alternative to shortwave broadcasting.

More powerful satellites now cover larger populated areas of the Earth than ever before, translating into a huge audience for broadcasters.

The good news isn't restricted to broadcasters. Consumers benefit from the mass production of digital satellite receivers, capable of producing high quality video and audio signals, at similar cost to an analog receiver a few years ago.

Depending upon your (earthly!) location, there are between eight and twelve satellites visible from Australia. These satellites carry around 200 channels of international programming.

While many of these are broadcast in the language of the country of origin (which is a great source for learning a language), there are enough English language channels to provide a great source of international news, documentaries and general entertainment.

C-band and Ku-band

There are two frequency bands utilised by satellite operators, "C" band and "Ku" band. Both are in the super high frequency (SHF) region of the electromagnetic spectrum (SHF goes from 3 to 30GHz, with wavelengths between 10cm and 1cm)

By international convention, C-band signals are transmitted in the 3.4-4.2GHz area. Unfortunately there are also some terrestrial services that operate in this region, so satellite signals do not rule exclusively here.

As the amount of power able to be transmitted by a satellite is limited by the available spacecraft power supply, efficient use must be made of this limited resource.

C-band signals are used for coverage of wide landmass areas because they are less affected by rain attenuation. Because they are intended for wide area coverage, the average signal level is far less than the spot beams used to cover smaller, populated areas.

Ku-band signals are transmitted (at least for our part of the world) in the 12.25-12.75GHz region and are generally used by satellite operators to illuminate specific populated parts of the world with strong signals.

For example, Pay-TV services use the Ku-band because they can target areas more effectively and efficiently. In Australia, most Pay-TV operators can provide adequate signals, with some margin for rain fade, using only 65cm dishes.

However, these signals are concentrated along the east coast and areas outside this "footprint" require a much larger dish for adequate reception.

Rain attenuation is more severe at these frequencies, so higher power must be used to overcome this problem. But the main advantage of Ku-band remains the size of the required dish.

Incidentally, the term "Ku" is used to identify a certain section of the overall band. The "Ku" band goes from 10.7-15.4GHz, the "K" band stretches from 15.4-27.5GHz, while the "Ka" band goes from 27.5-50GHz.

What is of main interest to us here are those free-to-air international signals on the C band.

How it works

Most enthusiasts are familiar with the principle of geostationary satellites.

But if you're not, basically the satellite is placed about 37,000km above the equator and appears to travel at the same speed and direction as the point directly "below" it on Earth.

A 2.3m C-band mesh dish mounted in a suburban backyard. Note the heavy-duty steel mounting pipe: this is set in concrete another 1.5m into the ground to prevent the dish moving in high winds. The mesh construction also assists this.

Of course, the satellite travels very much faster through space than the point on Earth moves. But the important point is that it moves at a speed which keeps it in the same relative position as that point on the ground.

The Earth's gravity constantly tries to pull the satellite out of orbit but at roughly 37,000km the centripetal force of the moving satellite exactly balances the pull of the earth's gravity. So the satellite neither falls to Earth nor spins out into space.

Therefore, the satellite appears to be in a fixed position. In practice, it's not quite that simple – regular "adjustment" firings of the satellite's rocket motors are required to keep it in geostationary orbit. When the limited amount of rocket fuel on board eventually runs out, the satellite will fall and probably burn up on re-entry.

This fixed position simplifies things significantly, because a fixed dish can now be used as there is no need to move the dish to follow, or "track" a moving satellite. This is quite different to LEO satellites (low earth orbiting) such as those used by GPS and weather satellite services.

By way of contrast, a 3m C-band solid dish in a commercial installation. This required a crane to lift it into position and very extensive anchoring to the flat roof. Windage can be a real problem with solid dishes, especially up high.

The only reason to change the position of the dish is to lock onto the signal from another satellite.

Satellites can be launched from a number of sites around the world, using multi-stage launchers to propel the satellite to the final orbit. By contrast, the USA's Space Shuttle can take the satellite to an altitude of 200 Km, where an "apogee" kick motor boosts the satellite into the final orbit.

There are now commercial launch sites in Russia, China, India, Japan, USA, French Guiana and from the Boeing "Sea Launch" platform in the Atlantic Ocean. A consortium is also reported to be currently trying to put together a commercial site in Australia using the now-largely-disused Woomera research centre in South Australia.

What you need

Basically an international satellite TV reception system comprises a dish of suitable size, an LNB (low noise block down converter), a feedhorn, a digital satellite receiver and connecting cables. In some cases, a multi-system video standards converter may be required.

The simplest implementation is a system designed to look at one satellite. The dish is simply pointed in the right direction and a single coaxial cable runs inside to the satellite receiver and TV set.

A more comprehensive (and complex) system is one that has been fitted with a motor, allowing access to all visible satellites.

This system relies on a particular type of dish mount called a "polar" mount. This achieves polar tracking of the geostationary arc using only one motor.

The most obvious component of the system is the dish. Typically, for domestic use, the reflector is constructed from expanded aluminium mesh, supplied as four pre-assembled panels. This reflector is mounted on a support ring, which in turn sits on top of a mounting post.

Commercial dishes are often one piece spun aluminium construction, making transport and mounting a far more difficult proposition.

Due to the mesh construction, the reflector is semi transparent, and hence not nearly as instrusive as a solid dish. That's important when it comes to satisfying neighbours and local councils.

Size does matter!

The dish shape is a parabola. The unbelievably tiny signals which arrive at the dish's surface bounce off it and, because of the parabolic shape, concentrate at the dish's focal point.

The lower the signal levels, the larger the dish required. It's not so much that C-band signals require a large dish because they are longer wavelength (even though that is true!), it's because they are invariably much lower in level than Ku-band signals.

The further away from the satellite you are (ie, the higher your latitude), the less signal you will receive . Again, the larger the dish you will need.

The same applies to satellites located further around the equator from your location. Satellites located on your longitude will require a certain sized dish, while satellites on distant longitudes will require larger dishes.

Ultimately, where the satellite is located below the horizon from your location, no dish, not even a monster the size of the Parkes radio telescope, will be able to receive signals from that satellite because there is a little barrier called the Earth in the way.

Therefore, when you hear people talking about watching programs from domestic USA or European satellites,

A C-band Low Noise Block Downconverter/Filter (LNBF) together with its associated feed horn. These devices are made to very tight tolerances due to the extremely high frequencies involved.

they are talking through their hats (or should that be through their Earth?).

Undoubtedly, what they are watching is a USA or European program received by a much closer earth station and re-transmitted on one of the satellites you *can* see from Australia!

It can be shown mathematically that at best (ie, an unobstructed path) you cannot view a satellite more than 81° from your longitude. As Sydney, for example, is at 151°E, that limits you to satellites located from 70°E to 128°W.

To adequately capture C-band signals at latitudes between, say, Brisbane and Melbourne, a dish of around 2.3m minimum diameter is required. Further south, you might need a 3m dish, or even larger. Further north, you might get away with 1.5m or so. Again, these sizes assume your satellite is reasonably close to your longitude.

So why do TV stations and satellite earth stations have such enormous (10m+) dishes? They are there to capture every last femtovolt of signal to ensure rock-solid reception, good enough for commercial applications. And they may also be looking at satellites close to the horizon.

Feedhorn and LNBF

Mounted at the focal point of the dish, supported by three or four arms, is an assembly called the feedhorn and LNBF (low noise block downconverter/filter).

The feedhorn "looks" at the reflector surface, and collects the signal reflected from the surface of the dish, concentrating the signal into a piece of waveguide to which the LNBF is connected.

The parts of the LNBFs name are significant. It must have *very* low electrical noise (so it doesn't introduce any significant noise of its own to what is a very tiny amount of signal anyway). And it must be able to convert a whole "block" of frequencies to lower frequencies which (a) are within the range of the receiver and (b) won't be as severely attenuated by the length of coaxial cable between it and the receiver.

(There will always be some attenuation of the signal along the coax and the higher the frequency, the greater the attenuation).

Remember that the incoming signal is within the frequency band of 3.4-4.2GHz, so we need to convert the signal to a more manageable frequency to run down a piece of coax, if we are to have any hope of getting the signal to the receiver!

The LNBF has an internal local oscillator at 5150MHz, and this mixes with the incoming signal to produce a block of intermediate frequencies (IF) from 950-1450MHz. That's a far more manageable range!

For maximum spectrum efficiency, most satellites transmit signals of both polarities (horizontal and vertical), so the LNB has two probes (one for each polarity) that can be remotely selected by the satellite receiver.

By convention, cables used in satellite TV are 75 ohm and it is important that a good quality cable is used to connect the LNBF to the receiver. For best results RG-6/U quad shield coax is recommended. The quad shielding ensures that any adjacent RF field (generated by 2-way radio, mobile and cordless phones, etc) does not interfere with the satellite IF signal being fed down the cable.

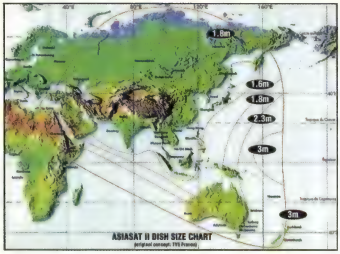
The dynamic range of most satellite receivers allows signals to be received anywhere between –20dBm and –50dBm, so some cable attenuation can be tolerated. Typically RG6, the coax most used for satellite receivers, has 25dB attenuation per 33m (100ft) at 1000MHz, so this is a about the maximum length we can use without amplification. The use of a 20dB line amplifier can extend this considerably.

Coming indoors

The only indoors component for the system (apart from the bit of coax that enters the building!) is the satellite receiver. The receiver takes the IF input and processes this digital stream to produce composite video and audio signals.

The digital receiver connects like any other audio/video

A typical digital receiver for C-band TV. MPEG-2 digital DVB compliant, his one retails for around $495 and has 4000 channel capability.



This map of Asiasat II's (100.5°E) "footprint" gives a good idea of the size of dish required for various areas. Note that the footprints are not circular – combinations of satellite transmitters and antennas are used to achieve the best footprint over populated areas.

component in a home entertainment system: composite video and/or SVHS video output, stereo line audio outputs, and RF (generally UHF) modulated output. Most receivers have at least two sets of A/V outputs for routing to VCR, TV, etc.

OK, so now that we have all these components in place, just what is there to see ?

There are really two reasons why free to air satellite TV signals exist. Either they are an extension of international shortwave broadcasting, or they are "fortuitous".

Over the last few years, satellite TV has taken over from the more traditional shortwave broadcasting. For example, the BBC no longer transmits on shortwave but they do produce a satellite TV channel, BBC World.

Other examples of government-operated satellite channels include Deutsche Welle (Germany), Worldnet (USA), NHK (Japan) and our own ABC Asia to name a few. These are deliberately set up to promote the culture, lifestyle and customs of the country of origin. These signals are of great interest to tourists, expatriates living overseas, schools, universities, and hotels. Such broadcasters normally produce a satellite "TV Guide" which can be accessed through their internet web sie.

The second type of free-to-air satellite TV signals encountered, are those that are "fortuitous" – another word for lucky! Many of these are not specifically intended for public consumption (for example, a broadcaster's link between one country and another) but suitably equipped satellite enthusiasts can view these signals. Every now and then you can see a real gem – like a movie transfer.

All such signals are subject to copyright which is designed to prevent commercial use being made from these signals.

SC

*** Garry Cratt is Technical Director of Av-comm Pty Ltd, suppliers of satellite TV equipment and peripherals.**

Receiving Pay-TV and other encrypted services

While this article has concentrated on C-band, free-to-air services which can be received and viewed by anyone with a suitable dish and receiver, there has been a lot of discussion over whether it is possible to receive Ku-band signals, such as those from Pay-TV service providers, and whether having your own dish and receiver is legal.

Of course, *technically speaking* Ku-band signals can be received with suitable equipment, otherwise satellite Pay-TV wouldn't be possible.

But it's not quite as simple as pointing your dish in the right direction and tuning in. Nor, apparently, is it now legal.

For a start, Pay-TV services are encrypted (with the exception of one channel – TV Shopping Network). So they have to be decrypted before you can watch them (that's one of the things the Pay-TV set-top-box does!).

Second, Pay-TV providers don't take kindly to people watching their service for free. That's why the set-top-box is provided with a smart card, a digital "key" which unlocks the box.

This key is periodically changed by a signal from the satellite which turns the box off if you haven't paid your bill or it is unauthorised. All you'll see on your TV set is a message such as "unknown service" or "this channel is encrypted".

There are a number of ways the service providers do this but the most usual is to periodically change the "country code" (or coco) after a message from the satellite tells the decoder that it is about to be changed. If the coco being transmitted and the coco stored on the card don't match, your signal disappears. So stolen set-top-boxes and cards only work for a short time. (That's one reason that there isn't a huge market in stolen boxes).

Finally, there is now legislation designed to stop you receiving Pay-TV signals without paying for them, even if you work out how to decrypt the signals yourself. Owning, buying and selling satellite dishes and receivers is *not* illegal but trading in the smart cards designed to make those receivers decrypt signals definitely is.

And even if you are particularly clever and are able to program your own smart card, since March 2002 there has been legislation to prevent you obtaining the benefit of a received Pay-TV satellite signal unless it is with the authorisation of the provider – ie, you've paid for it!

Unless you pay for it, don't hold your breath for authorisation! (In fact, it's rarely, if ever, given – they come and install their own equipment even if you have your own.)

And finally, a tale: in the US, service providers have been known to broadcast "stings" – offers so good they're impossible to resist. But they are also specifically coded so that legitimate viewers don't even see them. When people respond to these amazingly good offers, they know they've caught themselves some pirates!

Aaaaarrrrrr, me hearties . . .

NEXT MONTH: Putting together your own satellite TV system
(including a special system discount offer – exclusive to SILICON CHIP readers).

OVERLEAF: Currently available C-band digital f-t-a services

C-BAND FREE-TO-AIR DIGITAL CHANNEL LIST

FREQ	USER	SR (symbol rate)	FEC (forward error correction)	Video	Polarity	5.150 LO	5.700 LO	Origin
APSTAR 2R@76.5° E								
3705	Channel News Asia	6111	3/4	PAL	Vertical	1445 MHz	1995 MHz	China
3796	DD NE	2500	3/4	PAL	Vertical	1354 MHz	1904 MHz	India
3848	TVB8	13280	3/4	PAL	Horizontal	1302 MHz	1852 MHz	Hong Kong
3976	I Cable	5000	3/4	PAL	Vertical	1174 MHz	1724 MHz	Thailand
THAICOM 3 @78.5° E								
3424	Korean Central TV	3366	2/3	NTSC	Horizontal	1726 MHz	2276 MHz	N Korea
3448	TV Cambodia	6312	1/2	NTSC	Horizontal	1702 MHz	2252 MHz	Cambodia
3551	TRT	13330	3/4	PAL	Horizontal	1599 MHz	2149 MHz	Turkey
3600	Thai TV 5	26667	3/4	PAL	Horizontal	1500 MHz	2100 MHz	Thailand
	VTV 4							Vietnam
	ATN Bangla							India
	ETC Punjabi							
	CMM Music							
	Test pattern							India
3666	MR TV	4442	2/3	PAL	Horizontal	1484 MHz	2034 MHz	Burma
3671	MR TV	13330	3/4	NTSC	Horizontal	1479 MHz	2029 MHz	Cambodia
INSAT 2E@ 83° E								
3683	Asianet	4340	3/4	PAL	Vertical	1467 MHz	2017 MHz	China
3831	DD1 National	4998	3/4	PAL	Vertical	1319 MHz	1869 MHz	India
3911	DD2 Metro	4998	3/4	PAL	Vertical	1239 MHz	1789 MHz	India
4005	ETV bouquet	27000	3/4	PAL	Vertical	1145 MHz	1695 MHz	India
ASIASAT 2 @ 100.5° E								
3660	Saudi TV 1	27500	3/4	PAL	Vertical	1490 MHz	2039 MHz	Saudi
	Muslim TV							Saudi
	Kuwait Space Channel							Kuwait
	Jame-Jam Network							Iran
IRIB 3								Saudi
3705	Satlink adhoc	5632	3/4	PAL	Vertical	1445 MHz	1995 MHz	Europe
3706	Henan TV China	4418	3/4	PAL	Horizontal	1444 MHz	1994 MHz	China
3714	Satlink adhoc	5632	3/4	PAL	Vertical	1436 MHz	1986 MHz	Europe
3717	Quinghai TV	4418	3/4	PAL	Horizontal	1433 MHz	1983 MHz	China
3720	Fujian TV China	4418	3/4	PAL	Horizontal	1430 MHz	1980 MHz	China
3727	Jiangxi TV China	4418	3/4	PAL	Horizontal	1423 MHz	1973 MHz	China
3734	Liaoning TV China	4418	3/4	PAL	Horizontal	1416 MHz	1966 MHz	China
3799	APTN news feeds	5632	3/4	PAL	Horizontal	1351 MHz	1901 MHz	Europe
3806	GX TV	4418	3/4	PAL	Vertical	1344 MHz	1894 MHz	China
3813	Shaanxi TV China	4418	3/4	PAL	Vertical	1337 MHz	1887 MHz	China
3820	AH TV	4418	3/4	PAL	Vertical	1330 MHz	1880 MHz	China
3827	Jiangsu TV	8410	3/4	PAL	Horizontal	1323 MHz	1873 MHz	Mongolia
3827	JSTV	4418	3/4	PAL	Vertical	1323 MHz	1873 MHz	China
3830	Northern Mongolia TV2	8410	3/4	PAL	Horizontal	1320 MHz	1870 MHz	Mongolia
3834	Hei Long Jiang TV	4418	3/4	PAL	Vertical	1316 MHz	1866 MHz	China
3840	Guangdong TV	4418	3/4	PAL	Horizontal	1310 MHz	1860 MHz	China
3847	Hunan TV China	4418	3/4	PAL	Horizontal	1303 MHz	1853 MHz	China
3854	Hubei TV China	4418	3/4	PAL	Horizontal	1296 MHz	1846 MHz	China
3872	Jilin Satellite Channel	4418	3/4	PAL	Vertical	1278 MHz	1828 MHz	China
3880	Worldnet USA	20400	3/4	PAL	Horizontal	1270 MHz	1820 MHz	USA
4000	Deutsche Welle	28125	3/4	PAL	Horizontal	1150 MHz	1700 MHz	Germany
	RAI							Italy
	TV5							France
	TVe1							Spain
	RTPi							Portugal
4020	Dubai Sports	27500	3/4	PAL	Vertical	1130 MHz	1680 MHz	UAE
	Dubai Business							
	Dubai EDTV							Europe

ASIASAT 3 @° 105.5° E

3700	Bharathi TV	27500	3/4	PAL	Vertical	1450 MHz	2000 MHz	India
	Kaveri TV							India
3714	MS TV	5868	3/4	PAL	Horizontal	1436 MHz	1986 MHz	China
3742	SABe	3300	3/4	PAL	Vertical	1408 MHz	1958 MHz	India
3755	Arirang TV	4418	7/8	PAL	Vertical	1395 MHz	1945 MHz	Korea
3760	Now TV	26000 7/8	PAL	Horizontal	1290 MHz	1940 MHz		USA
	Bloomberg Asia							
	Splash TV							
	S/S Music							
3820	Speedcast TV	27500 3/4	PAL	Vertical	1330 MHz	1880 MHz		China
3900	Indus TV	27900 7/8	PAL	Vertical	1250 MHz	1800 MHz		India
4000	Phoenix I	26850 7/8	NTSC	Horizontal	1150 MHz	1700 MHz		China
	Xing Kong							
	Phoenix C							
	Channel V							
4095	Sun TV	5555	3/4	PAL	Horizontal	1055 MHz	1605 MHz	China
4129	CCTV 3,4,9	13240 3/4	PAL	Horizontal	1021 MHz	1571 MHz		China

PALAPA C2 @ 113° E

3473	RCTI	8000	3/4	PAL	Horizontal	1677 MHz	2227 MHz	Indonesia
4000	Channel News Asia	26085	3/4	PAL	Horizontal	1150 MHz	1700 MHz	Taiwan
4080	Swara TV	28125	3/4	PAL	Horizontal	1070 MHz	1620 MHz	Indonesia
	Quick TV							
	Anteve							
	Global TV							
	Metro TV							
4184	TPI digital	6700	3/4	PAL	Vertical	966 MHz	1516 MHz	Indonesia

PAS-8 @ 166° E

3740	MTV China	27500	3/4	PAL	Horizontal	1410 MHz	1960 MHz	China
3852	Tzu Chi TV	28000	5/6	NTSC	Horizontal	1298 MHz	1848 MHz	Taiwan
	Hai Hua Satellite TV							Taiwan
	29 radio services							
	Power TV							Taiwan
3829	CCTV 4,3,9	13240	3/4	PAL	Horizontal	1321 MHz	1871 MHz	China
3880	Lakbay TV	28694	3/4	PAL	Vertical	1270 MHz	1820 MHz	Philippines
3900	CNBC	27500	3/4	PAL	Horizontal	1250 MHz	1800 MHz	USA
3940	EWTN	27690	7/8	NTSC	Horizontal	1210 MHz	1760 MHz	USA
	Fox News feed							USA
	BBC							UK
4020	ESPN	26470	3/4	NTSC	Horizontal	1130 MHz	1680 MHz	USA++
4060	NHK World	26470	3/4	NTSC	Horizontal	1090 MHz	1640 MHz	Japan
	Channel J							Japan
	NIME TV							Japan
4180	ABC Asia	27500	3/4	PAL	Horizontal	970 MHz	1520 MHz	Australia
	Radio Australia							

PAS-2@ 169° E

3743	BBC World (Singapore)	21800	3/4	NTSC	Vertical	1407 MHz	1957 MHz	UK
3771	YTN Korea	11574	3/4	NTSC	Horizontal	1382 MHz	1932 MHz	Korea
3837	RAI Australia	13331	3/4	PAL	Vertical	1372 MHz	1922 MHz	Italy
	RAI Radio							Italy
3903	CBS/ Adhoc feeds	30800	3/4	NTSC	Horizontal	1249 MHz	1797 MHz	USA
Bloomberg TV								USA
BloombergRadio								
	ABC Asia							
	Radio Australia							
3992	Fox MUX	26470	7/8	NTSC	Vertical	1158 MHz	1708 MHz	USA
3940	Napa feeds	7498	2/3	PAL	Vertical	1210 MHz	1760 MHz	
3942	Napa feeds	6620	2/3	NTSC	Horizontal	1208 MHz	1758 MHz	
4026	TVBSUSA	22000	3/4	NTSC	Vertical	1124 MHz	1674 MHz	Taiwan

INTELSAT 701 @ 180°E

3769	TBN	20000	7/8	PAL	RHCP	1381MHz	1931MHz	USA
3886	Worldnet	25000	3/4	PAL	RHCP	1264MHz	1814MHz	USA

+ = audio only * = 0900-1800UTC $ = 1800-0900UTC LAST UPDATE: 6/9/02

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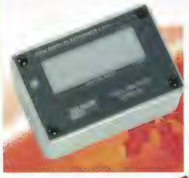

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Silicon Chip Nov '92

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SILICON CHIP Aug '02

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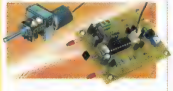
K 3121 SILICON CHIP May '02 **$39.88**



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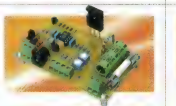
K 3131 SILICON CHIP Sep '02 **$69.84**



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T 4763

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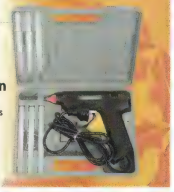

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M 5110

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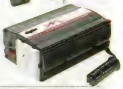
$86



digitor 12V to 240V 300W Inverter

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M 5111

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digitor 12V to 240V 800W Inverter

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MICROMITTER

A miniature FM stereo transmitter

Here's an FM stereo transmitter that's really easy to build. It's based on the new BH1417F chip from Rohm and is crystal-locked to the selected frequency so there's no drift. Best of all, there are no messy tuning coils to wind and adjust.

By JOHN CLARKE

THIS NEW STEREO FM Micromitter is capable of broadcasting good quality signals over a range of about 20 metres. It's ideal for broadcasting music from a CD player or from any other source so that it can be picked up in another location.

For example, if you don't have a CD player in you car, you can use the Micromitter to broadcast signals from a portable CD player to your car's radio. Alternatively, you might want to use the Micromitter to broadcast signals from your lounge-room CD player to an FM receiver located in another part of the house or by the pool.

Because it's based on a single IC, this unit is a snack to build and fits easily into a small plastic utility box. It broadcasts on the FM band (ie, 88-108MHz) so that its signal can be received on any standard FM tuner or portable radio.

However, unlike previous FM transmitters published in SILICON CHIP, this new design is not continuously variable over the FM broadcast band. Instead, a 4-way DIP switch is used to select one of 14 preset frequencies. These are available in two ranges covering from 87.7-88.9MHz and 106.7-107.9MHz in 0.2MHz steps.

No tuning coils

We first published an FM stereo transmitter in SILICON CHIP in Octo-

Main Features

- Very compact
- Battery or plugpack operation
- Stereo transmission
- Standard FM tuner required to receive transmission
- Crystal locked operation
- 14 selectable transmission frequencies

ber 1988 and followed this up with a new version in April 2001. Dubbed the Minimitter, these earlier versions were based on the Rohm BA1404 IC which is now obsolete.

On both these earlier units, the alignment procedure requires careful adjustment of the ferrite tuning slugs within two coils (an oscillator coil and a filter coil), so that the RF output matched the frequency selected on the FM receiver. However, some constructors had difficulty with this because the adjustment was quite sensitive.

In particular, if you had a digital (ie, synthesised) FM receiver, you had to set the receiver to a particular frequency and then carefully tune the transmitter frequency "through" it. In addition, there was some interaction between the oscillator and filter coil adjustments and this confused some people.

That problem doesn't exist on this new design, since there is no frequency alignment procedure. Instead, all you have to do is set the transmitter frequency using the 4-way DIP switch and then dial-up the programmed frequency on your FM tuner.

After that, it's just a matter of adjusting a single coil when setting up the transmitter, to set for correct RF operation.

Improved specifications

The new FM Stereo Micromitter is now crystal-locked which means that the unit does not drift off frequency over time. In addition, the distortion, stereo separation, signal-to-noise ratio and stereo locking are much improved on this new unit compared to the earlier designs. The specifications panel has further details.

BH1417F transmitter IC

At the heart of the new design is the BH1417F FM stereo transmitter IC made by the Rhom Corporation. As already mentioned, it replaces the now obsolete BA1404 used in the previous designs.

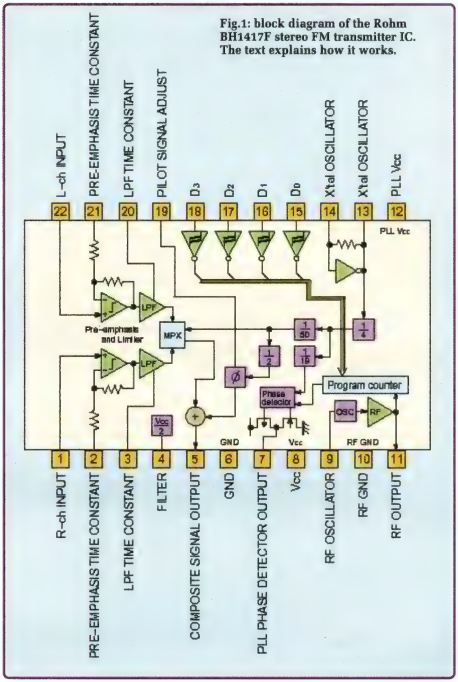


Fig.1: block diagram of the Rohm BH1417F stereo FM transmitter IC. The text explains how it works.

Fig.1 shows the internal features of the BH1417F. It includes all the processing circuitry required for stereo FM transmission and also the crystal control section which provides precise frequency locking.

As shown, the BH1417F includes two separate audio processing sections, for the left and right channels. The left-channel audio signal is applied to pin 22 of the chip, while the right channel signal is applied to pin 1. These audio signals are then applied to a pre-emphasis circuit which boosts those frequencies above a 50μs time constant (ie, those frequencies above 3.183kHz) prior to transmission.

Basically, pre-emphasis is used to improve the signal-to-noise ratio of the received FM signal. It works by using a complementary de-emphasis circuit in the receiver to attenuate the boosted treble frequencies after demodulation, so that the frequency response is restored to normal. At the

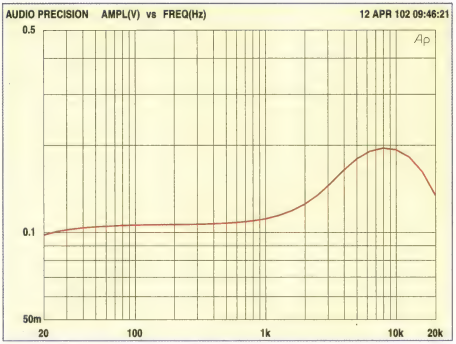


Fig.2: this frequency versus output level plot shows the composite level (pin 5). The 50µs pre-emphasis at around 3kHz causes the rise in response, while the 15kHz low pass roll off produces the fall in response above 10kHz.

same time, this also significantly reduces the hiss that would otherwise be evident in the signal.

The amount of pre-emphasis is set by the value of the capacitors connected to pins 2 & 21 (note: the value of the time constant = 22.7kΩ x the capacitance value). In our case, we use 2.2nF capacitors to set the pre-emphasis to 50µs which is the Australian FM standard.

Signal limiting is also provided within the pre-emphasis section. This involves attenuating signals above a certain threshold, to prevent overloading the following stages. That in turn prevents over-modulation and reduces distortion.

The pre-emphasised signals for the left and right channels are then processed through two low-pass filter (LPF) stages, which roll off the response above 15kHz. This rolloff is necessary to restrict the bandwidth of the FM signal and is the same frequency limit used by commercial broadcast FM transmitters.

The outputs from the left and right LPFs are in turn applied to a multiplex (MPX) block. This is used to effectively produce sum (left plus right) and difference (left - right) signals which are then modulated onto a 38kHz carrier. The carrier is then suppressed (or removed) to provide a double-sideband suppressed carrier signal. It is then mixed in a summing (+) block with a 19kHz pilot tone to give a composite signal output (with full stereo encoding) at pin 5.

The phase and level of the 19kHz pilot tone are set using a capacitor at pin 19.

Fig.3 shows the spectrum of the composite stereo signal. The (L+R) signal occupies the frequency range from 0-15kHz. By contrast, the double sideband suppressed carrier signal (L-R) has a lower sideband which extends from 23-38kHz and an upper sideband from 38-53kHz. As noted, the 38kHz carrier is not present.

The 19kHz pilot tone is present, however, and this is used in the FM receiver to reconstruct the 38kHz subcarrier so that the stereo signal can be decoded.

The 38kHz multiplex signal and 19kHz pilot tone are derived by dividing down the 7.6MHz crystal oscillator located at pins 13 & 14. The frequency is first divided by four to obtain 1.9MHz and then divided by 50 to obtain 38kHz. This is then divided by two to derive the 19kHz pilot tone.

In addition, the 1.9MHz signal is divided by 19 to give a 100kHz signal. This signal is then applied to the phase detector which also monitors the program counter output. This program counter is actually a programmable divider which outputs a divided down value of the RF signal.

The division ratio of this counter is set by the voltage levels at inputs D0-D3 (pins 15-18). For example, when D0-D3 are all low, the programmable counter divides by 877. Thus, if the RF oscillator is running at 87.7MHz, the divided output from the counter will be 100kHz and this matches the frequency divided down from the 7.6MHz crystal oscillator (ie, 7.6MHz divided by 4 divided by 19).

In practice, the phase detector output at pin 7 produces an error signal to control the voltage applied to a varicap diode. This varicap diode (VC1) is shown on the main circuit diagram (Fig.4) and forms part of the RF oscillator at pin 9. Its frequency of oscillation is determined by the value of the inductance and the total parallel capacitance.

Since the varicap diode forms part of this capacitance, we can alter the RF oscillator frequency by varying its value. In operation, the varicap diode's capacitance varies in proportion to the DC voltage applied to it by the output of the PLL phase detector.

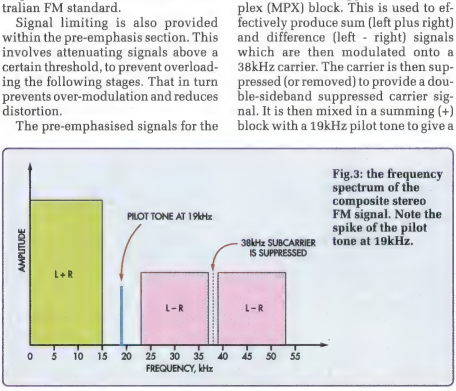


Fig.3: the frequency spectrum of the composite stereo FM signal. Note the spike of the pilot tone at 19kHz.

In practice, the phase detector adjusts the varicap voltage so that the divided RF oscillator frequency is 100kHz at the program counter output. If the RF frequency drifts high, the frequency output from the programmable divider rises and the phase detector will "see" an error between this and the 100kHz provided by the crystal division.

As a result, the phase detector reduces the DC voltage applied to the varicap diode, thereby increasing its capacitance. And this in turn decreases the oscillator frequency to bring it back into "lock".

Conversely, if the RF frequency drifts low, the programmable divider output will be lower than 100kHz. This means that the phase detector now increases the applied DC voltage to the varicap to decrease its capacitance and raise the RF frequency. As a result, this PLL feedback arrangement ensures that the programmable divider output remains fixed at 100kHz and thus ensures stability of the RF oscillator.

By changing the programmable divider we can change the RF frequency. So, for example, if we set the divider to 1079, the RF oscillator must operate at 107.9MHz for the programmable divider output to remain at 100kHz.

Frequency modulation

Of course, in order to transmit audio information, we need to frequency modulate the RF oscillator. We do that by modulating the voltage applied to the varicap diode using the composite signal output at pin 5.

Note, however, that the average frequency of the RF oscillator (ie, the carrier frequency) remains fixed, as set by the programmable divider (or program counter). As a result, the transmitted FM signal varies either side of the carrier frequency according to the composite signal level – ie, it is frequency modulated.

Circuit details

Refer now to Fig.4 for the full circuit of the Stereo FM Micromitter. As expected, IC1 forms the main part of the circuitry with a handful of other components added to complete the FM stereo transmitter.

The left and right audio input signals are fed in via 1µF bipolar capacitors and then applied to attenuator circuits consisting of 10kΩ fixed resistors and 10kΩ trimpots (VR1 & VR2). From there, the signals are coupled into pins 1 & 22 of IC1 via 1µF electrolytic capacitors.

Note that the 1µF bipolar capacitors are included to prevent DC current flow due to any DC offsets at the signal source outputs. Similarly, the 1µF capacitors on pins 1 & 22 are necessary to prevent DC current in the trimpots, since these two input pins are biased at half-supply. This half-supply rail is decoupled using a 10µF capacitor at pin 4 of IC1.

The 2.2nF pre-emphasis capacitors are at pins 2 & 21, while the 150pF capacitors at pins 3 & 20 set the low-pass filter rolloff point. The pilot level can be set with a capacitor at pin 19 – however, this is not usually necessary as the level is generally quite suitable without adding the capacitor.

In fact, adding a capacitor here only reduces the stereo separation because the pilot tone phase is altered compared to the 38kHz multiplex rate.

The 7.6MHz oscillator is formed by connecting a 7.6MHz crystal between pins 13 & 14. In practice, this crystal is connected in parallel with an internal inverter stage. The crystal sets the frequency of oscillation, while the 27pF capacitors provide the correct loading.

The programmable divider (or program counter) is set using switches at pins 15, 16, 17 & 18 (D0-D3). These inputs are normally held high via 10kΩ resistors and pulled low when the switches are closed. Table 1 shows

Parts List

1 PC board, code 06112021, 78 x 50mm.
1 plastic utility box, 83 x 54 x 31mm
1 front panel label, 79 x 49mm
1 7.6MHz crystal (Hi-Q International (Australia) Pty Ltd. GB02E QC49/A 7600.000) (X1)
1 SPDT subminiature switch (Jaycar ST-0300, Altronics S 1415 or equiv.) (S5)
2 PC-mount RCA sockets (switched) (Altronics P 0209, Jaycar PS 0279)
1 2.5mm PC-mount DC power socket
1 4-way DIP switch
1 4mm tapped coil former (L1)
1 4mm F29 ferrite slug
1 680nH (0.68µH) surface mount inductor (1210A case) (Farnell 608-282 or similar)
1 68nH surface mount inductor (0603 case) (Farnell 323-7886 or similar)
1 100mm length of 1mm enamelled copper wire
1 50mm length of 0.8mm tinned copper wire
1 1.6m length of hookup wire
3 PC stakes
1 4 x AAA cell holder (required for battery operation)
4 AAA cells (required for battery operation)
3 10kΩ vertical trimpots (VR1-VR3)

Semiconductors
1 BH1417F Rohm surface-mount FM stereo transmitter (Fairmont Marketing) (IC1)
1 78L05 low-power regulator (REG1)
1 MPSA13 Darlington transistor (Q1)
1 ZMV833ATA (AE version SOD323 package) surface mount varicap diode (Fairmont Marketing) (VC1)
1 24V 1W zener diode (ZD1)
1 1N914, 1N4148 diode (D1)

Capacitors
2 100µF 16VW PC electrolytic
5 10µF 25VW PC electrolytic
2 1µF bipolar electrolytic
2 1µF 16VW electrolytic
1 47nF (.047µF) MKT polyester
2 10nF (.01µF) ceramic
3 2.2nF (.0022µF) MKT polyester
1 330pF ceramic
2 150pF ceramic
1 39pF ceramic
1 33pF ceramic
2 27pF ceramic
1 22pF ceramic
1 10pF ceramic
1 3.3pF ceramic

Resistors (0.25W, 1%)
1 22kΩ, 1 100Ω
8 10kΩ, 1 56Ω
1 5.1kΩ, 2 39Ω
2 3.3kΩ

SPECIFICATIONS

Transmission frequencies	87.7MHz to 88.9MHz in 0.2MHz steps 106.7MHz to 107.9MHz in 0.2MHz steps (14 total)
Total Harmonic Distortion (THD)	typically 0.1%
Pre-emphasis	typically 50µs
Low Pass Filter	15kHz/20dB/decade
Channel separation	typically 40dB
Channel balance	within ± 2dB (can be adjusted with trimpots)
Pilot modulation	15%
RF output power (EIRP)	typically 10µW when using inbuilt attenuator
Supply voltage	4-6V
Supply current	28mA at 5V
Audio input level	....220mV RMS maximum at 400Hz and 1dB compression limiting

how the switches are set to select one of 14 different transmission frequencies.

The RF oscillator output is at pin 9. This is a Colpitts oscillator and is tuned using inductor L1, the 33pF & 22pF fixed capacitors and varicap diode VC1.

The 33pF fixed capacitor performs two functions. First, it blocks the DC voltage applied to VC1 to prevent current from flowing into L1. And second, because it is in series with VC1, it reduces the effect of changes in the varicap capacitance, as "seen" by pin 9.

This, in turn, reduces the overall frequency range of the RF oscillator due to changes in the varicap control voltage and allows better phase lock loop control.

Similarly, the 10pF capacitor prevents DC current flow into L1 from pin 9. Its low value also means that the tuned circuit is only loosely coupled and this allows a higher Q factor for the tuned circuit and easier starting of the oscillator.

Modulating the oscillator

The composite output signal appears at pin 5 and is fed via a 10µF capacitor to trimpot VR3. This trimpot sets the modulation depth. From there, the attenuated signal is fed via another 10µF capacitor and two 10kΩ resistors to varicap diode VC1.

As mentioned previously, the phase lock loop control (PLL) output at pin 7 is used to control the carrier frequency. This output drives high-gain Darlington transistor Q1 and this, in turn, applies a control voltage to VC1 via two 3.3kΩ series resistors and the 10kΩ isolating resistor.

The 2.2nF capacitor at the junction of the two 3.3kΩ resistors provides high-frequency filtering.

Additional filtering is provided by the 100µF capacitor and 100Ω resistor connected in series between Q1's base and collector. The 100Ω resistor allows the transistor to respond to transient changes, while the 100µF capacitor provides low-frequency filtering. Further high-frequency filtering is provided by the 47nF capacitor connected directly between Q1's base and collector.

The 5.1kΩ resistor connected to the 5V rail provides the collector load. This resistor pulls Q1's collector high when the transistor is off.

FM output

The modulated RF output appears at pin 11 and is fed to a passive LC bandpass filter. Its job is to remove any harmonics produced by the modulation and in the RF oscillator output. Basically, the filter passes frequencies in the 88-108MHz band but rolls off signal frequencies above and below this.

The filter has a nominal impedance of 75Ω and this matches both IC1's pin 11 output and the following attenuator circuit.

Two 39Ω series resistors and a 56Ω shunt resistor form the attenuator and this reduces the signal level into the antenna. This attenuator is necessary to ensure that the transmitter operates at the legal allowable limit of 10µW.

Power supply

Power for the circuit is derived from either a 9-16V DC plugpack or a 6V battery.

In the case of a plugpack supply, the power is fed in via on/off switch S5 and diode D1 which provides reverse polarity protection. ZD1 protects the circuit against high-voltage transients, while regulator REG1 provides a steady +5V rail to power the circuit.

Alternatively, for battery operation, ZD1, D1 and REG1 are not used and the through connections for D1 and REG1 are shorted. The absolute maximum supply for IC1 is 7V, so 6V battery operation is suitable; eg 4 x AAA cells in a 4 x AAA holder.

Construction

A single PC board coded 06112021 and measuring just 78 x 50mm holds all the parts for the Micromitter. This is housed into a plastic case measuring 83 x 54 x 30mm.

First, check that the PC board fits neatly into the case. The corners may need to be shaped to fit over the corner pillars on the box. That done,

BANDPASS FILTER OPTION

We've designed the PC board so that it can accept a different bandpass filter at the pin 11 RF output of IC1. This filter is made by Soshin Electronics Co. and is labelled GFWB3. It is a small 3-terminal printed bandpass filter and operates in the 76-108MHz frequency band.

The advantage of using this filter is that it has much steeper rolloff above and below the FM band. This results in less sideband interference at other frequencies. The drawback is that this filter is very difficult to obtain.

In practice, the filter replaces the 39pF capacitor, with the central earth terminal of the filter connecting to the PC board earth. That is why there is a hole between the 39pF capacitor leads. The 39pF and 3.3pF capacitors and the 68nH and 680nH inductors are then not required, while the 68nH inductor is replaced with a wire link.

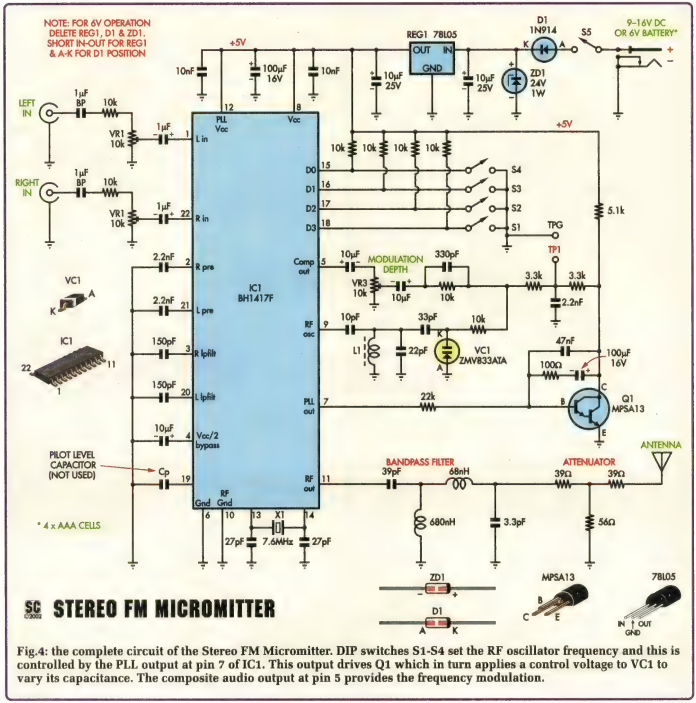


Fig.4: the complete circuit of the Stereo FM Micromitter. DIP switches S1-S4 set the RF oscillator frequency and this is controlled by the PLL output at pin 7 of IC1. This output drives Q1 which in turn applies a control voltage to VC1 to vary its capacitance. The composite audio output at pin 5 provides the frequency modulation.

check that the holes for the DC socket and RCA socket pins are the correct size. If L1's former doesn't have a base (see below), it is mounted by pushing it into a hole that is just sufficiently tight to hold it in place. Check that this hole has the correct diameter.

Fig.5(a) & Fig.5(b) show how the parts are mounted on the PC board. The first job is to install several surface-mount components on the copper side of the PC board. These parts include IC1, VC1 and two inductors.

You will need a fine-tipped soldering iron, tweezers, a strong light and a magnifying glass for this job. In particular, the soldering iron tip will have to be modified by filing it to a narrow screwdriver shape.

IC1 and the varicap diode (VC1) are polarised devices, so be sure to orient them as shown on the overlay. Each part is installed by holding it in place with the tweezers and then soldering one lead (or pin) first. That done, check that the component is correctly positioned before carefully soldering the remaining lead(s).

In the case of the IC, it's best to first lightly tin the underside of each of its pins before placing it onto the PC board. It's then just a matter of heating each lead with the soldering iron tip to solder it in place.

Be sure to use a strong light and a magnifying glass for this work. This will not only make the job easier but will also allow you to check each connection as it is made. In particular, make sure that there are no shorts between adjacent tracks or IC pins.

Finally, use your multimeter to

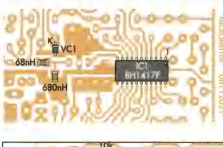


Fig.5(a): this diagram shows how the four surface-mount parts are installed on the copper side of the PC board. Make sure that IC1 & VC1 are correctly oriented.

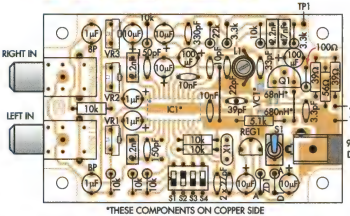


Fig.5(b): here's how to install the parts on the top of the PC board to build the plugpack-powered version. Note that IC1, VC1 and the 68nH & 680nH inductors are surface mount devices and are mounted on the copper side of the board as shown in Fig.5(a)

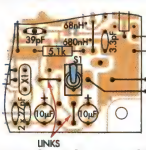


Fig.6: here's how to modify the board for the battery-powered version. It's just a matter of leaving out D1, ZD1 & REG1 and installing a couple of wire links.

Fig.7: this diagram shows the winding details for coil L1. The former will have to be trimmed so that it sits no more than 13mm above the board surface. Use silicone sealant to holder the former in place, if necessary.

check that each pin is indeed connected to its respective track on the PC board.

The remaining parts are all mounted on the top side of the PC board in the usual manner. If you are building the plugpack-powered version, follow the overlay diagram shown in Fig.5. Alternatively, for the battery powered version, leave out ZD1 and the DC socket and replace D1 & REG1 with wire links as shown in Fig.6.

Top assembly

Begin the top assembly by installing the resistors and wire links. Table 3 shows the resistor colour codes but we also recommend that you use a digital multimeter to check the values. Note that most of the resistors are mounted end-on to save space.

Once the resistors are in, install PC stakes at the antenna output and the TP GND and TP1 test points. This will make it much easier to connect to these points later on.

Next, install trimpots VR1-VR3 and the PC-mount RCA sockets. The DC socket, diode D1 and ZD1 can then be inserted for the plugpack-powered version.

The capacitors can go in next, taking care to install the electrolytic types with the correct polarity. The NP (non-polarised) or bipolar (BP) electrolytic types can be installed either way. Push them all the way down into their mounting holes, so that they sit no more than 13mm above the PC board (this is to allow the lid to fit correctly when the AAA batteries are mounted under the PC board inside the box).

The ceramic capacitors can also be installed at this stage. Table 2 shows their marking codes, to make it easy for you to identify the values.

Table 1: Frequency Selection

FREQUENCY, MHz	S1	S2	S3	S4
87.7	1	1	1	1
87.9	1	1	1	0
88.1	1	1	0	1
88.3	1	1	0	0
88.5	1	0	1	1
88.7	1	0	1	0
88.9	1	0	0	1
(Uncontrolled)	1	0	0	0
106.7	0	1	1	1
106.9	0	1	1	0
107.1	0	1	0	1
107.3	0	1	0	0
107.5	0	0	1	1
107.7	0	0	1	0
107.9	0	0	0	1
(Uncontrolled)	0	0	0	0

SWITCHES: 0 = OPEN, 1 = CLOSED

Winding coil L1

Fig.7 shows the winding details for coil L1. It comprises 2.5 turns of 1mm enamelled copper wire (ECW) wound onto a tapped coil former fitted with an F29 ferrite slug.

Two types of formers are available – one with a 2-pin base (which can be soldered directly to the PC board) and one that comes without a base. If the former has a base, it will first have to be shortened by about 2mm, so that its overall height (including the base) is 13mm. This can be done using a fine-toothed hacksaw.

That done, wind the coil, terminate the ends directly on the pins and solder the coil into position. Note that the turns are adjacent to each other (ie, the coil is close wound).

Alternatively, if the former doesn't have a base, cut off the collar at one end, then drill a hole in the PC board at the L1 position so that the former is a tight fit. That done, push the former into its hole, then wind the coil so that the lowest winding sits on the top surface of board.

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
47nF	47n	473
10nF	10n	103
2.2nF	2n2	222
330pF	330p	331
150pF	150p	151
39pF	39p	39
33pF	33p	33
27pF	27p	27
22pF	22p	22
10pF	10p	10
3.3pF	3p3	3.3

Be sure to strip away the insulation from the wire ends before soldering the leads to the PC board. A few dabs of silicone sealant can then be used to ensure that the coil former stays in place.

Finally, the ferrite slug can be inserted into the former and screwed in so that its top is about flush with the top of the former. Use a suitable plastic or brass alignment tool to screw in the slug – an ordinary screwdriver may crack the ferrite.

Crystal X1 can now be installed. This is mounted by first bending its leads by 90 degrees, so that it sits horizontally across the two adjacent 10kΩ resistors (see photo). The board assembly can now be completed by installing the DIP switch, transistor Q1, regulator (REG1) and the antenna lead.

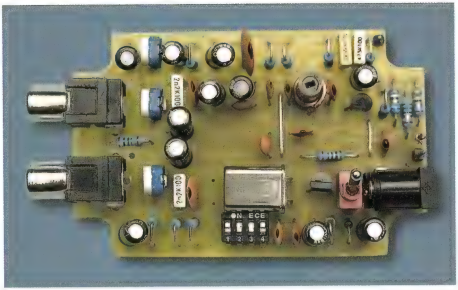
The antenna is simply a half-wave dipole type. It consists of a 1.5m length of insulated hookup wire, with one end soldered to the antenna terminal. This should give good results as far as transmission range is concerned.

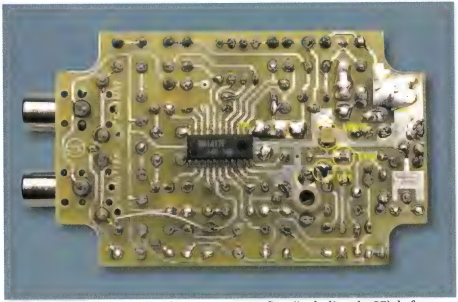
Preparing the case

Attention can now be turned to the plastic case. This requires holes at one end to accommodate the RCA sockets, plus holes at the other end for the antenna lead and the DC power socket (if used).

In addition, a hole must be drilled in the lid for the power switch.

It's also necessary to remove the internal side mouldings along the walls of the case to a depth of 15mm





It's best to install the four surface-mount parts first (including the IC), before installing the remaining parts on the top of the PC board. Note how the body of the crystal lies across the two adjacent 10kΩ resistors (top photo).

Table 3: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	22kΩ	red red orange brown	red red black red brown
8	10kΩ	brown black orange brown	brown black black red brown
1	5.1kΩ	green brown red brown	green brown black brown brown
2	3.3kΩ	orange orange red brown	orange orange black brown brown
1	100Ω	brown black brown brown	brown black black black brown
1	56Ω	green blue black brown	green blue black gold brown
2	39Ω	orange white black brown	orange white black gold brown

Above: the circuit can be powered from 4 x 1.5V AAA cells if you wish to make the unit portable. Note that the battery holder requires some modification in order to fit everything inside the case (see text).

Left: this photo shows how the case is drilled to take the RCA sockets, the power socket and the antenna lead.

below the top edge of the box, in order to fit the PC board. We used a sharp chisel to remove these but a small grinder could be used instead. That done, you also need to remove the end ribs under the lid in order to clear the tops of the RCA and DC sockets. The front-panel label can then be attached to the lid.

The battery-powered version has a AAA cell-holder mounted upside down in the box, with the base of the holder in contact with the copper side of the PC board. There is just sufficient room for this holder and the PC board to mount inside the case with the following provisos:

(1). All parts except for power switch S5 must not protrude above the surface of the PC board by more than 13mm. This means that the electrolytic capacitors must sit close to the PC board and that L1's former must be cut to the correct length.

(2). The AAA cell holder is about 1mm too thick and should be filed down at each end, so that the cells protrude slightly over the top of the holder.

(3). The tops of the RCA sockets may also require shaving slightly, so that there is no gap between the box and the lid after assembly.

Test & adjustment

This part is a real snack. The first job is to tune L1 so that the RF oscillator operates over the correct range. To do that, follow this the step-by-step procedure:

(1). Set the transmission frequency using the DIP switches, as shown in Table 1. Note that you need to select a frequency that is not used as a commercial station in your area, otherwise interference will be a problem.

(2). Connect your multimeter's common lead to TP GND and its positive lead of to pin 8 of IC1. Select a DC volts range on the meter, apply power to the Micromitter and check that you get a reading that's close to 5V if you're using a DC plugpack.

Alternatively, the meter should show the battery voltage if you're using AAA cells.

(3). Move the positive multimeter lead to TP1 and adjust the slug in L1 for a reading of about 2V.

The oscillator is now correctly tuned. No further adjustments to L1 should be required if you subsequently switch to another frequency within

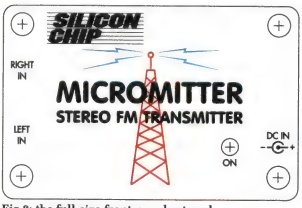


Fig.8: the full-size front-panel artwork.

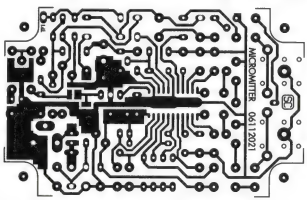
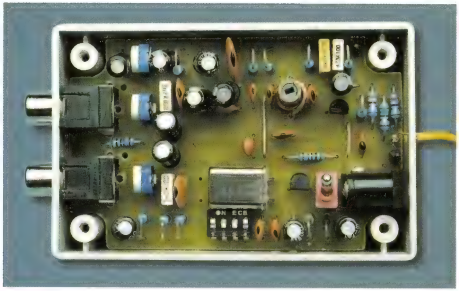
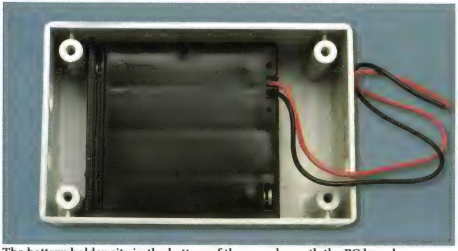


Fig.9: full-size etching pattern for the PC board.





The battery holder sits in the bottom of the case, beneath the PC board.

the selected band. However, if you change to a frequency that's in the other band, L1 will have to be readjusted for a reading of 2V at TP1.

Setting the trimpots

All that remains now is to adjust trimpots VR1-VR3 to set the signal level and modulation depth. The step-by-step procedure is as follows:

(1). Set VR1, VR2 & VR3 to their centre positions. VR1 and VR2 can be adjusted by passing a screwdriver through the centres of the RCA sockets, while VR3 can be adjusted by moving the 1μF capacitor in front of it to one side.

(2). Tune a stereo FM tuner or radio to the transmitter frequency. The FM tuner and transmitter should initially be placed about two metres apart.

(3). Connect a stereo signal source (eg, a CD player) to the RCA socket inputs and check that this is received by the tuner or radio.

(4). Adjust VR3 anticlockwise until the stereo indicator goes out on the receiver, then adjust VR3 clockwise from this position by 1/8th of a turn.

(5). Adjust VR1 and VR2 for best sound from the tuner – you will have to temporarily disconnect the signal source to make each adjustment. There should be sufficient signal to "eliminate" any background noise but without any noticeable distortion.

Note particularly that VR1 and VR2 must each be set to the same position, to maintain the left and right channel balance.

That's it – your new Stereo FM Micromitter is ready for action. **SC**

ACA COMPLIANCE

This FM broadcast band stereo transmitter is required to comply with the Radiocommunications Low Interference Potential Devices (LIPD) Class Licence 2000, as issued by the Australian Communications Authority.

In particular, the frequency of transmission must be within the 88-108MHz band at a EIRP (Equivalent Isotropically Radiated Power) of 10μW and with FM modulation no greater than 180kHz bandwidth. The transmission must not be on the same frequency as a radio broadcasting station (or repeater or translator station) operating within the licence area.

Further information can be found on the www.aca.gov.au web site. The class licence information for LIPDs can be downloaded from: www.aca.gov.au\legal\licence\class\lipd.rtf

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

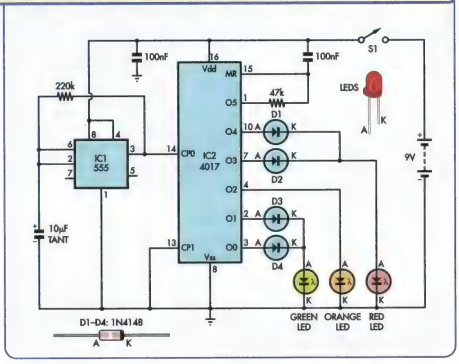
Traffic lights for model cars or model railways

Kids these days seem to have most things you see in the toy shops, so if you have a son or grandson who has a collection of cars, here is something he will really appreciate. And it will be really special as you will be giving something made by you – a set of traffic lights for his cars.

This traffic light circuit uses a 555 timer IC as the master timer. The 220kΩ timing resistor and 10µF capacitor control the timing pulses, giving a period of about three seconds.

The 3-second output pulses are used to clock a 4017 decade counter whose outputs directly drive the green, orange and red LEDs. To obtain a longer time for the red and green lights compared with the orange light, two outputs are ORed using 1N4148 diodes for the red and green LEDs, while the orange is driven by one output only. This gives about 6 seconds for the red and green LEDs and 3 seconds for the orange.

When power is first applied, the RC network connected to pins 1 and 15 of IC2 resets the 4017 and the green LED cycle begins. The orange and red cycles follow and at the end of the red cycle, pin 1 will go high to reset the 4017 to start the green cycle all over again.



You can experiment with the cycle times by adjusting the 220kΩ resistor or by combining more or less 4017 outputs to achieve different ON times for the three LEDs.

The circuit is designed to be powered by a 9V battery and this is the maximum voltage that is recommended. This is because the LEDs are directly driven by the 4017 with no current limiting resistor being used. The 4017 naturally limits the current that it can supply to 15mA.

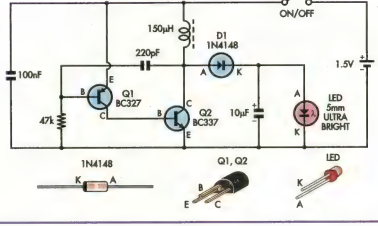
An extension of this project would be to make a second set of lights for the cross traffic. Here you would use the same 555 as a master timer for both sets of lights (otherwise chaos would ensue) and a separate 4017 to drive the three extra LEDs. Of course, you would have to take care and ensure that green and orange outputs on each set of lights correspond with red on the other!

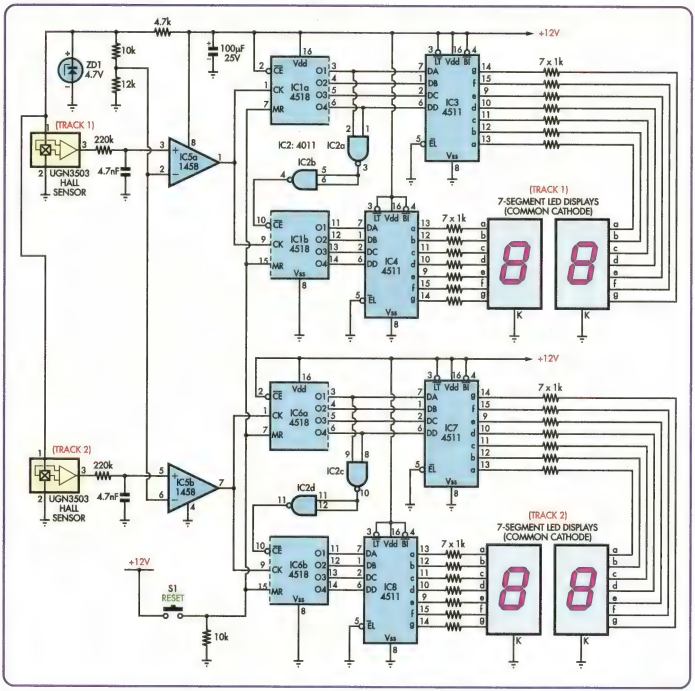
Jack Holliday,
Nathan, Qld. ($35)

LED torch uses blocking oscillator

This simple LED torch is driven by a 2-transistor blocking oscillator which steps up the voltage from a 1.5V cell. It relies on the inherent current limiting of the 150µH choke to protect the white LED from overdrive. With a 9V zener diode in place of the white LED, it could also provide a 9V supply provided the current drain is modest.

Peter Goodwin,
Southland, NZ. ($30)





AFX slot car lap counter

AFX slot car sets are very enjoyable but you can increase the fun with a lap counter. This circuit will count from 00 to 99, with independent counters for each track.

The sensing device used is a Hall effect sensor (UGN3503; available from (Dick Smith Electronics). One of these sensors is glued under a section of each track (printed side up); between the slot and one of the track rails is the best spot. In this position, it will allow the ground effects magnets on the cars to pass over them.

The sensor will provide a voltage of about 3V when a car passes over it and about 2V without a magnetic field.

Both counter circuits are identical, with dual op amp IC5 handling the signals from both sensors. IC5a and IC5b are wired as comparators, with a 2.5V reference derived from zener diode ZD1 via the 10kΩ and 12kΩ resistors.

Each time the output of IC5a goes high it clocks IC1a, a 4518 BCD counter. NAND gates IC2a & IC2b provide a carry out to the other half of IC1 for a 2-digit display. More counters may be cascaded this way to provide extra digits. The BCD outputs of IC1 drive 7-segment decoders IC3 & IC4 which drive common cathode LED displays.

Pushbutton S1 resets the counters to 00 for both tracks for the start of a new race.

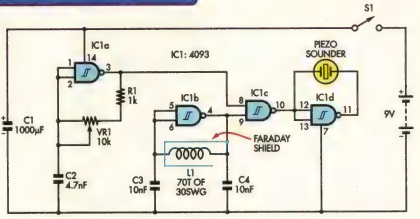
Placid Talia, Oakleigh, Vic.

Simple BFO metal locator

This circuit uses a single coil and nine components to make a particularly sensitive low-cost metal locator. It works on the principle of a beat frequency oscillator (BFO).

The circuit incorporates two oscillators, both operating at about 40kHz. The first, IC1a, is a standard CMOS oscillator with its frequency adjustable via VR1.

The frequency of the second, IC1b, is highly dependent on the inductance of coil L1, so that its frequency shifts in the presence of metal. L1 is 70 turns of 0.315mm enamelled copper wire wound on a 120mm diameter former. The Faraday shield is made of aluminium foil, which is wound around all but about 10mm of the coil and connected to pin 4 of IC1b.

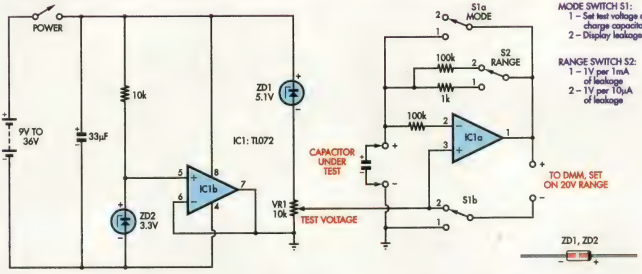


The two oscillator signals are mixed through IC1c, to create a beat note. IC1d and IC1c drive the piezo sounder in push-pull fashion, thereby boosting the output.

Unlike many other metal locators of its kind, this locator is particularly easy to tune. Around the midpoint setting of VR1, there will be a loud beat frequency with a null point in the middle. The locator needs to be tuned to a low frequency beat note to one or the other side of this null point.

Depending on which side is chosen, it will be sensitive to either ferrous or non-ferrous metals. Besides detecting objects under the ground, the circuit could serve well as a pipe locator.

Thomas Scarborough,
Cape Town, South Africa. ($35)



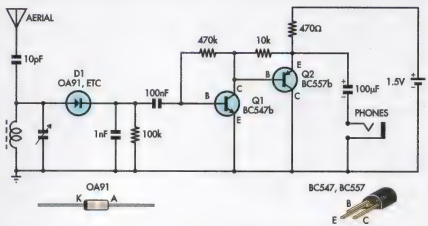
Capacitor leakage adaptor for DMMs

Used with a DMM on the 20V range, this circuit gives a rapid and direct measure of the leakage current of capacitors. There are two ranges, with maximum readings of about 20µA and 2mA, and the test voltage can be varied. This lets you test leakage at or near the capacitor's rated voltage.

In addition, the circuit can help determine the amount of internal electro-chemical activity, which reduces the capacitor's lifespan. For example, one 0.33F 5.5V super capacitor I tested has an open-circuit voltage that rises exponentially to about 0.8V over a period of 10 days.

Note: super capacitors are technically called electro-chemical capacitors but they store energy electrostatically like other capacitors.

To quantify the internal electrochemical activity of a capacitor using this circuit, simply measure the capacitor's "leakage" with the test voltage set to zero. If the reading is negative, the capacitor is self-charging with its plus terminal becoming positive with respect to its minus terminal. If the reading is greater



Simple AM radio receiver

This circuit is essentially an amplified crystal set. The inductor could be a standard AM radio ferrite rod antenna while the tuning capacitor is a variable plastic dielectric gang, intended for small AM radios.

The aerial tuned circuit feeds diode D1 which functions as the detector. A germanium type is far preferable to a silicon signal diode because its lower forward voltage enables it to work with smaller signals.

The detected signal from the diode is filtered to remove RF and the recovered audio is fed to a 2-transistor stage which drives a set of 32Ω phones from a Walkman-style player.

Peter Goodwin,
Southland, NZ. ($30)

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than zero, the capacitor is self-charging with its minus terminal becoming positive with respect to its plus terminal.

In the circuit, the 10kΩ potentiometer (VR1) adjusts the test voltage. Zener diode ZD1 limits the maximum test voltage to ensure that the output of IC1a can swing to at least 2V above the test voltage.

IC1b and associated components derive the ground rail from the single-ended supply. The negative supply voltage is fixed at -3.3V by ZD2 to give more range to the test voltage, which is derived from the positive supply.

The circuit will operate from any voltage in the range 9-36V but keep in mind that the maximum test voltage is 8.4V less than the supply voltage.

With S1 in position 1, IC1a is configured as a unity gain buffer and the DMM reads its output voltage. Without a test capacitor (CUT) connected, the DMM will display the test voltage. When a CUT is connected, it will be rapidly charged to the test voltage via S1a.

The 100kΩ resistor in series with the inverting input to IC1a protects the op amp in case a capacitor charged to a high voltage is connected to the test terminals, particularly when power to the circuit is off. However, it offers no protection against a charged capacitor being connected to the test terminals in reverse.

Position 2 of S1a configures the circuit to display the leakage of the capacitor. The feedback resistor around IC1a is set to 100kΩ or 1kΩ by switch S2, while S1b connects the DMM to show the difference between the test voltage and the output of IC1a.

In this position, IC1a maintains the test voltage across the CUT. Since no current flows into the op amp input, any leakage current flowing through the CUT must also flow through the selected feedback resistor (R). IC1a will therefore raise its output voltage above the test voltage by I x R volts, and this difference will be shown on the DMM.

To use the circuit, first set S2 to the desired range, then place S1 into position 1 and adjust the 10kΩ pot until the desired test voltage is shown on the DMM. That done, connect the capacitor to be tested and wait for the DMM reading to stabilise at the test voltage. Now switch S1 to position 2, whereupon the DMM will show the leakage of the capacitor.

Andrew Partridge,
Kuranda, Qld. ($45)

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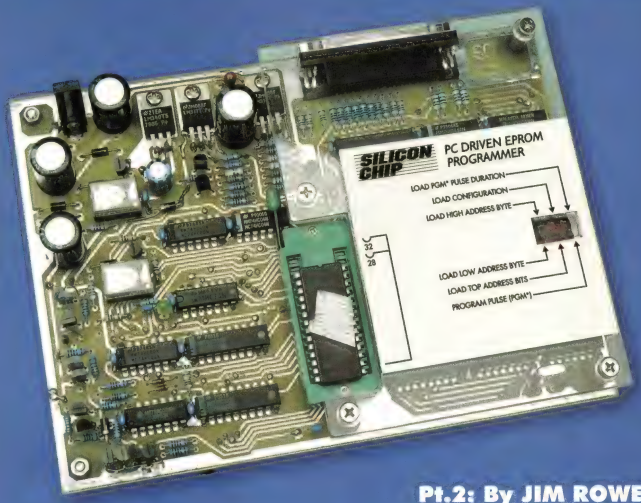


Pt.2: By JIM ROWE

A Windows-Based EPROM Programmer

This month, we explain how to assemble the programmer and the socket adaptors which allow it to read and program devices in either 24-pin DIL or 32-pin PLCC packages. We also explain how to check the programmer's basic hardware operation.

AS MENTIONED in the first article, the new programmer's hardware is built entirely on a double-sided PC board. This board is coded 07112021 and is designed to be "free standing" rather than mounted in a box.

Both the DB25 socket for the parallel cable (CON1) and the socket for the plugpack cable (CON2) are mounted directly on the rear edge of the board. The 32-pin ZIF socket which accepts the EPROMs (or adaptor sockets) is mounted centrally near the front.

To make it freestanding, the board is fitted with six small rubber feet for support. Four of the feet attach to the corners of the board, while the remaining two are fitted just to the front and rear of the ZIF socket.

We decided on this method of construction so that the programmer would be easy to put together. However, with a "naked" PC board, there's obviously no protection for the components against physical damage.

Perspex panel

Ideally, a full-size Perspex front panel could be mounted above the PC board to provide this protection. However, this wasn't really feasible here because there would have to be a large rectangular cutout to allow full access to the ZIF socket and its operating lever. And even with such a cutout, it would still be quite awkward to insert and remove EPROMs (and their socket adaptors) because the panel would have to be mounted quite high to clear the electrolytic capacitors and relays.

Because of this complication, we decided to compromise by using a "half-panel", as shown in the photo. This provides protection for just over half the board and allows for full identification of the six mode indica-or LEDs. It also provides a guide for tting 32-pin and 28-pin EPROMs thout restricting access to the ZIF ket.

his Perspex "half-panel" mounts e the PC board on four M3 tapped rs (12.5mm long). These also he "nuts" for the M3 machine which are used to attach four oard's rubber mounting feet. 5mm spacing ensures that the t nicely clears the LEDs, the ystal case and the DB25

ws the dimensions of the

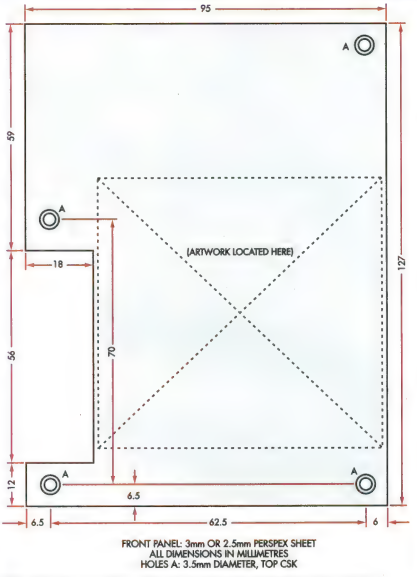


Fig.6: this diagram shows the dimensions of the Perspex front panel.

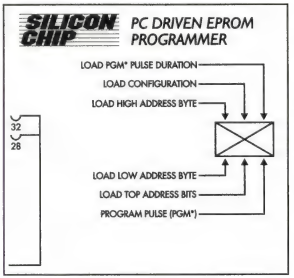


Fig.7: this is the full-size front panel artwork. The area marked with a cross is cut out so that the status LEDs can be seen through the Perspex.

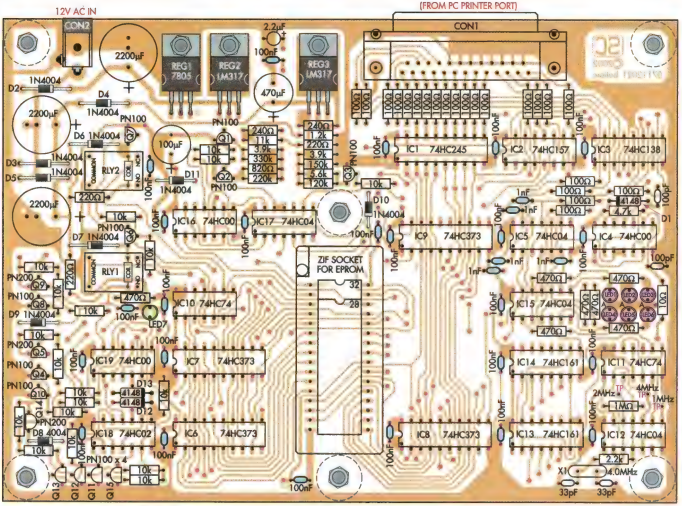

12V AC IN
CON2
(FROM PC PRINTER PORT)
CON1
REG1 7805
REG2 LM317
REG3 LM317
2200µF
470µF
2.2µF
100µF
1N4004
D2
D4
D6
D3
D5
D7
D11
D10
D1
RLY2
RLY1
IC1 74HC245
IC2 74HC157
IC3 74HC138
IC4 74HC00
IC5 74HC04
IC6 74HC373
IC7 74HC373
IC8 74HC373
IC9 74HC373
IC10 74HC74
IC11 74HC74
IC12 74HC04
IC13 74HC161
IC14 74HC161
IC15 74HC04
IC16 74HC00
IC17 74HC04
IC18 74HC02
IC19 74HC00
ZIF SOCKET FOR EPROM
32
28
LED7
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
Q19
Q20
Q21
Q22
Q23
Q24
Q25
Q26
Q27
Q28
Q29
Q30
Q31
Q32
Q33
Q34
Q35
Q36
Q37
Q38
Q39
Q40

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	1MΩ	brown black green brown	brown black black yellow brown
1	330kΩ	orange orange yellow brown	orange orange black orange brown
1	220kΩ	red red yellow brown	red red black orange brown
1	150kΩ	brown green yellow brown	brown green black orange brown
1	120kΩ	brown red yellow brown	brown red black orange brown
1	11kΩ	brown brown orange brown	brown brown black red brown
19	10kΩ	brown black orange brown	brown black black red brown
1	5.6kΩ	green blue red brown	green blue black brown brown
1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
2	3.9kΩ	orange white red brown	orange white black brown brown
1	2.2kΩ	red red red brown	red red black brown brown
1	1.2kΩ	brown red red brown	brown red black brown brown
1	820Ω	grey red brown brown	grey red black black brown
7	470Ω	yellow violet brown brown	yellow violet black black brown
2	240Ω	red yellow brown brown	red yellow black black brown
3	220Ω	red red brown brown	red red black black brown
22	100Ω	brown black brown brown	brown black black black brown
1	10Ω	brown black black brown	brown black black gold brown

holes. The relays are identical, so they can go in either position.

Now for the semiconductor devices. The best procedure here is to fit the regulators first, then the ICs and finally the transistors and LEDs.

The regulators all mount horizontally, with their leads bent downwards by 90 degrees about 6mm away from the regulator packages. Their mounting tabs are each secured to the board using a 6mm x M3 machine screw and nut. There's no need to apply any heatsink compound to the underside of each device, although a thin smear will help keep them cool.

Note that the pins of all three regulators should be soldered to the pads on both sides of the board if there's no through-hole plating.

You can now install all the ICs. Be sure to fit the correct IC to each location and make sure they are all oriented correctly. They all face in the same direction, with pin 1 at bottom left.

Fit the PNP transistors first

There are 15 transistors in all – 12 PN100 NPN types and three PN200 PNP types. To make sure that you don't mix them up (which would cause the programmer to misbehave in strange ways), it's best to fit the three PN200s first. These go in the positions shown for Q5, Q9 and Q14, in the front-left quadrant of the board.

Orientate the transistors as shown and push them down as far as they will comfortably go before soldering their leads. Once they are in, you can fit the PN100s in the remaining positions.

The six red LEDs are fitted in two rows of three immediately to the right of IC15. Note that they all have their anode leads towards the "inside" of the group – ie, the two rows face in opposite directions. They should all be installed so that their bodies are 8mm above the board surface, so that their tops will be just below the Perspex front panel when it's later fitted.

Note the wire "via" just to the right of the LEDs. This connects all the LED anodes to the +5V supply rail. Be sure to fit this via if your board doesn't have plated-through holes, otherwise none of your mode indicator LEDs will work!

The remaining green LED (LED7) is used for power indication and is mounted just to the left of IC10. It should also sit 8mm above the board, its anode lead towards IC19.

The 4.0MHz quartz crystal and ZIF socket can go in next. Push the crystal all the way down onto the board and solder its leads quickly, so that you don't overheat the crystal inside. The ZIF socket must be installed with its operating lever on the left.

Make sure that all the pins of the ZIF socket pass through the PC board before soldering it into place.

Finally, you can complete the board assembly by installing the DB25 connector (CON1) and the power socket (CON2). Note that the holes for CON2's lugs really need to be small slots. If necessary, they can be filed to shape using a jeweller's rat-tail file, so that the socket fits easily.

Table 2: Capacitor Codes

Value	IEC Code	EIA Code
100nF	100n	104
1nF	1n	102
100pF	100p	101
33pF	33p	33

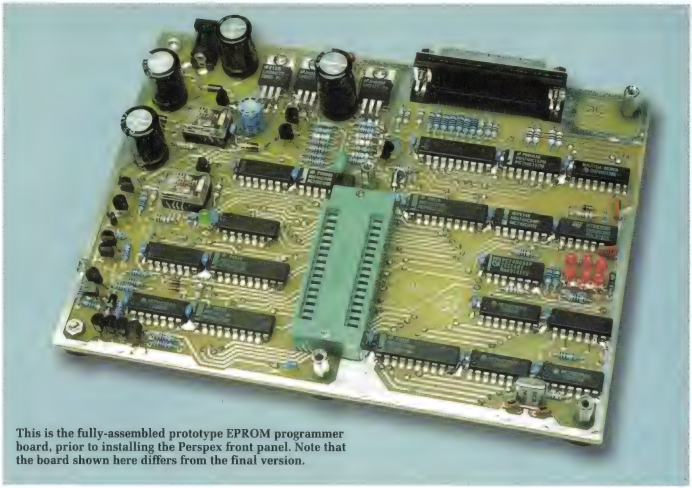
Quick inspection

At this stage it's a good idea to carefully inspect all of your soldered joints on both sides of the board. Check to ensure that you haven't made any dry joints or left solder bridges to cause problems later on.

Once you are satisfied that everything is OK, you can fit the six rubber to the board. As mentioned earlier these mount on the underside of the board using 6mm x M3 machine screws. The two mounting screws on the lefthand side of the board are then fitted with normal M3 hex nuts on the top, while the remaining four take the 12.5mm tapped spacers used to support the Perspex front panel.

Front panel

If you buy a complete kit, chances are the Perspex front panel will come pre-cut with screen-printed lettering.



This is the fully-assembled prototype EPROM programmer board, prior to installing the Perspex front panel. Note that the board shown here differs from the final version.

However, we'll assume here that you're making the panel yourself.

The front panel is made from 3mm thick Perspex sheet and all the dimensions are shown in Fig.6. Note that the four mounting holes (A) are countersunk, to take the 6mm x M3 countersink-head screws which attach the panel to its support spacers.

When the panel has been cut to shape, drilled and has its edges nicely smoothed (a sharp perspex edge can cut you almost as readily as glass), try sitting it on the support spacers. The panel should just clear the tops of the LEDs and the quartz crystal case. If it doesn't clear the LEDs, desolder their leads and move them down.

If your crystal's case is just a whisker taller than 12.5mm, even with it mounted down hard against the board, don't despair. The solution to this involves nothing more than placing a small flat washer on the top of each support spacer before you fit the front panel. This increases the board-to-panel spacing by almost a millimetre, which should be more than enough to clear the crystal case.

Don't attach the front panel at this stage – that step comes later, after the check-out procedure.

Check-out time

You are now ready to power up the programmer and quickly check it for correct hardware operation – at least in terms of the basics. To do this, you'll need to fit the correct 2.5mm plug to the 12V 1A plugpack lead, so that it can mate with connector CON2.

Before actually applying power, set your DMM (or multimeter) to measure DC voltage and connect its negative lead to the earthy side of the board. The top of the mounting screw for REG1 is a convenient point to make this connection.

Now apply power and check first that the green power LED is glowing. If it is, use the DMM to check the voltages at the cathode ends of D2, D5 & D4. These should measure about +17.5V, +18V and +35V respectively.

If the LED isn't glowing, or if any voltage is not even near its correct value, switch off immediately and look for wiring mistakes. The most likely cause of any trouble is fitting one or more diodes, transistors or ICs the wrong way around

Note that at this stage, there may also be a number of the red LEDs glowing. That's because the programmer isn't connected to either a PC printer port or an EPROM. Don't worry about this – it's to be expected.

If all is well so far, try measuring the voltages at the output pins of REG1, REG2 and REG3. The output of REG1 should be within a few millivolts of 5.00V, because this is the supply line for most of the programmer's ICs and LEDs. However, the outputs of REG2 and REG3 can be at various levels, depending on the state of their control circuits in this "no-PC-connected" state.

For example, the output of REG2 can be at any of three different voltage levels – 3.7V, 5.7V or 6.95V – depending on the control signals applied to transistors Q1 and Q2. So if you measure any of these three voltages or very close to them, REG2 and its switching circuitry are probably working correctly.

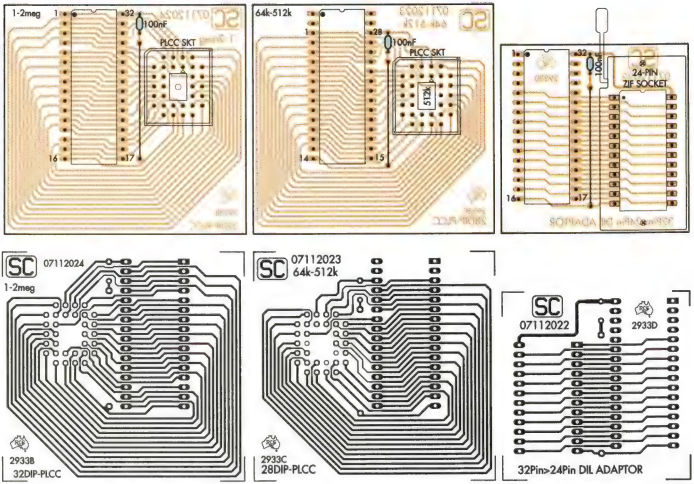


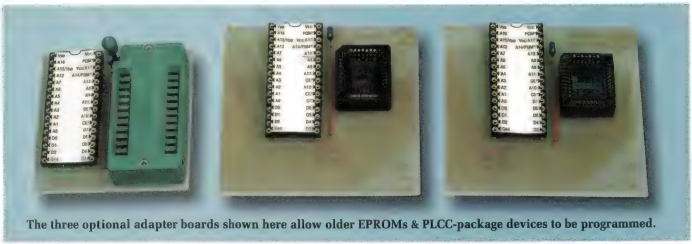
Fig.9: here are the parts layout diagrams for the three adaptor boards, together with their full-size PC patterns. All three use wire-wrap sockets with long tails to form 32-pin "plugs" that fit into the programmer's main ZIF socket.

Similarly, the output of REG3 can be at either of two voltage levels, depending on the control signal applied to transistor Q3: 21.2V or 12.95V. So if you measure either of these voltages or very close to them, REG3 and its switching circuitry are probably working correctly too.

If everything is OK so far, check the voltage at pin 14 of the 14-pin ICs, pin 16 of the 16-pin ICs and pin 20 of the 20-pin ICs. These should all measure +5V.

The last quick check you can perform at this stage is to use an oscilloscope or a frequency counter to check the clock signals at the three test points in the front righthand corner of the board. As indicated on the overlay diagram (Fig.6), you should be able to measure 4MHz, 2MHz and 1MHz signals respectively on the three terminal pins.

If you are using an oscilloscope, it should also show these signals to be square-waves with an amplitude of close to 5V peak-to-peak. If so, your crystal clock oscillator and timing divider are working correctly and your programmer is ready for final testing



The three optional adapter boards shown here allow older EPROMs & PLCC-package devices to be programmed.

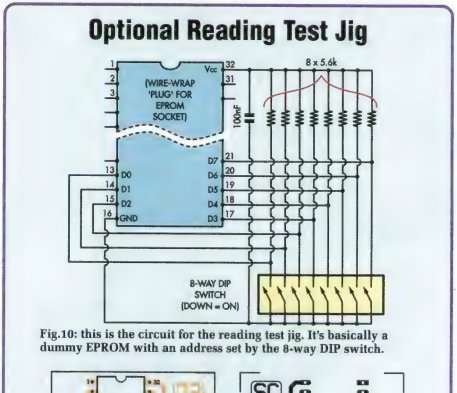


Fig.10: this is the circuit for the reading test jig. It's basically a dummy EPROM with an address set by the 8-way DIP switch.

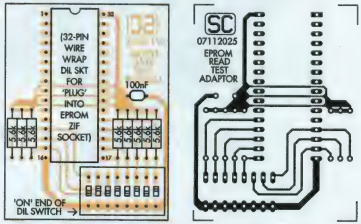
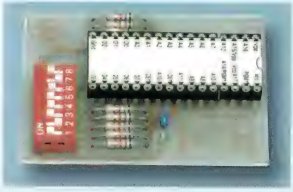


Fig.10: the parts layout and full-size board pattern for the reading test jig. Building it is entirely optional (see text).



This is the completed reading test jig. It will come in handy if you need to service the programmer at a later stage.

with the software. We'll discuss this in Pt.3 next month.

There are some more hardware tests you can carry out before connecting the programmer to a PC but these require a "dummy printer port" test jig like the one we plan to describe next month in a separate small article. This simple little gizmo will allow you to check the programmer's pulse timing, configuration and mode decoding circuitry, if you wish.

It can also be used to check out printers but you'll have to wait until next month for more information on this device.

The socket adaptors

The small socket adaptors are designed to allow the programmer to also handle EPROMs in 24-pin DIL and 32-pin PLCC packages, as well as the 28-pin and 32-pin DIL devices which plug directly into the main ZIF socket.

There are three of these adaptors – one for 24-pin DIL devices and the other two for PLCCs. So why do we need two different adaptors for PLCC devices? The reason is that although all devices with capacities up to 2Mb are in 32-pin packages, the 1Mb and 2Mb devices have different connections compared to the 64-512Kb devices.

Another adaptor is required for the 24-pin DIL devices for almost the same reason. Although they're physically compatible with a 32-pin socket, these devices have more connection differences than the programmer's configuration circuits can handle. The adaptor overcomes this problem.

Fig.9 shows the parts layout diagrams for the three adaptors. There's very little in them and all three use wire-wrap sockets with long tails to form 32-pin "plugs" that fit into the programmer's main ZIF socket. The 24-pin adaptor then has a 24-pin ZIF socket of its own to take that size of EPROMs, while the two PLCC adaptors have standard 32-pin PLCC sockets instead.

Note that we've used standard 32-pin PLCC sockets because ZIF sockets for PLCCs are very expensive – about $150 each! Fortunately, it's quite easy to insert PLCC devices into the standard sockets by hand and then remove them again with low-cost extractor tools (like the DSE T-4655).

Apart from the wire-wrap "plugs" and their interconnected sockets, the only other items on each adaptor board are a single wire link and a 100nF multilayer monolithic bypass capacitor, on the EPROM Vcc line. So they're each easy to put together.

Reading test jig

During the programmer development, we also made up a little plug-in

Parts List

1 PC board (double-sided with plated-through holes), code 07112021, 178 x 127mm
1 4.00MHz quartz crystal (X1)
1 12V 1A AC plugpack supply
1 DB25F socket, 90° PC-mount
1 DC connector, 2.5mm PC-mount
2 12V SPDT miniature relays, PC mount
1 32-pin zero insertion force (ZIF) IC socket
6 12.5mm-diameter rubber feet
9 M3 x 6mm machine screws, round head
5 M3 nuts
4 M3 tapped spacers, 12.5mm long
4 M3 x 6mm machine screws, CSK head
1 Perspex sheet, 95 x 127mm (3mm thick)

Semiconductors

1 74HC245 octal buffer (IC1)
1 74HC157 4 x 2 multiplexer (IC2)
1 74HC138 3-to-8 decoder (IC3)
3 74HC00 quad NAND gate (IC4, IC16, IC19)
4 74HC04 hex inverter (IC5, IC12, IC15, IC17)
4 74HC373 octal latch (IC6, IC7, IC8, IC9)
2 74HC74 dual flipflop (IC10, IC11)
2 74HC161 4-bit PL counter (IC13, IC14)
1 74HC02 quad NOR gate (IC18)
12 PN100 NPN transistors (Q1, Q2, Q3, Q4, Q6, Q7, Q8, Q10, Q11, Q12, Q13, Q15)
3 PN200 PNP transistors (Q5, Q9, Q14)
3 1N4148 switching diodes (D1, D12, D13)
10 1N4004 1A power diodes (D2-D11)
6 3mm red LEDs (LED1-LED6)
1 3mm green LED (LED7)
1 7805 positive 5V regulator (REG1)
2 LM317 adjustable regulators (REG2, REG3)

Capacitors

3 2200µF 25V PC electrolytic
1 470µF 63V PC electrolytic
1 100µF 16V PC electrolytic
1 2.2µF 35V tag tantalum
24 100nF multilayer monolithic
5 1nF metallised polyester
2 100pF NPO ceramic
2 33pF NPO ceramic

Resistors (0.25W 1%)

1 1MΩ	2 3.9kΩ
1 330kΩ	1 2.2kΩ
1 220kΩ	1 1.2kΩ
1 150kΩ	1 820Ω
1 120kΩ	7 470Ω
1 11kΩ	2 240Ω
19 10kΩ	3 220Ω
1 5.6kΩ	22 100Ω
1 4.7kΩ	1 10Ω

jig to test the unit's read mode operation. However, although this device is handy, you shouldn't really need one unless it's for servicing the programmer at a later stage. For that reason, we're providing the circuit and board overlay diagram for those readers who want to build one up.

Fig.10 shows the circuit details, while Fig.11 shows the parts layout on the PC board. Basically, it's a very simple "dummy EPROM" with only one address (or every address). It simply provides a pullup resistor for each data pin of the 32-pin EPROM socket, plus a set of eight DIP switches so that you can manually set each pin to either a "1" or a "0". This allows you to set up a data byte which can be read back by the computer software by sending the appropriate instructions.

Note, however, that because the jig "jams" its data on the programmer's internal data bus lines, it can't be left plugged in while you're trying to download configuration bytes, timing register bytes or write data bytes. It's purely to provide a data byte for testing the read functions.

Whether or not you build one of these little jigs is up to you. It won't cost you much but on the other hand, you don't really need one unless your programmer develops a fault.

Software

That's all for now. Next time, we plan to give you details of the Visual Basic for DOS software that's been developed to run the programmer. **SC**

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DECISION

Many years ago, you could buy gimmicky little devices which helped make decisions: just press the button and you got a "yes" or a "no" immediately. Here's the modern day version: you don't just get a yes or a no – you get one of four different decisions: an emphatic "definitely", a "maybe", a "no way" and even a "try again"! With just a handful of components, it's a great first electronics project to build.

Can't make a decision? Worried that if you make the wrong choice you'll get the blame? Well, here's your saviour: press the button and the decision is made for you. Instantly.

And if that decision turns out to be the wrong one, you can always say to your mum/dad/teacher/partner/boss/etc, "Look, it's not my fault. That was the decision the box made . . ."

How it works

There are two main parts to this project – an oscillator (based on IC1) and a LED driver (based on IC2).

In a nutshell, when you press the pushbutton, power is supplied to the circuit and the "reservoir" capacitor on the main supply rail charges to the battery voltage (3V). At the same time, the resistor and capacitor around one of the Schmitt NAND gates (IC1c) cause it to oscillate.

The word NAND is a contraction of NOT & AND. The "AND" part means that both inputs to the gate need to be a logic "high" for the gate to operate and the "NOT" means the output is opposite, or inverted, to the input. There is a "truth table" shown in Table 1 which shows what happens to the output, depending on what is occurring at the input.

The "Schmitt" part of the name refers to a feature of the threshold points, or triggering, of the gate. The voltage levels at which it triggers, either low or high, are quite precise but more importantly, are widely separated. This makes a Schmitt trigger more immune to noisy triggering waveforms.

As you can see, the two inputs to the gate are connected together, effectively turning it into an inverter. As such, the input and output can never be the same state – when the input is high, the output must be low and vice versa.

When you press and hold the button, the IC is powered up but at that instant the inputs are in a low state

Project by:
Trent Jackson

Words by:
Ross Tester

Should you build this project? Hey, the answer is already given for you!

(because the 1µF capacitor is not charged). Therefore the output is high.

The capacitor then starts to charge via the 68kΩ resistor from output to input.

When the capacitor voltage passes the gate's upper threshold voltage (ie, the input goes high), the output goes low. The capacitor then starts to discharge, the voltage eventually dropping below the gate's lower threshold voltage. The output then goes high again.

This keeps happening as long as power is applied to the circuit. It's called a "relaxation oscillator" and is a very easy way to make any form of pulse generator.

How fast?

The frequency at which it operates is determined by the values of the resistor and capacitor. The formula is 1/ 0.55 x RC, where R is in ohms and C is in Farads (note that – Farads, not microfarads).

Therefore if the resistor is *exactly* 68,000 ohms (unlikely!) and the capacitor is *exactly* 1µF (even more unlikely!), the frequency of this oscillator circuit will be 1/ 0.55 x 68,000 x 0.000001, or 1/0.0374, or approximately 26Hz (actually 26.7Hz).

Why did we say it was unlikely that the resistor and capacitor wouldn't be exactly what their marked value said?

If the resistor has a 1% tolerance, its actual value could be anywhere from 99% of 68,000 ohms (67,320Ω) to 101% (68,680Ω). And capacitors normally have a much wider tolerance – as much as 20% or more. So you can see we are not talking exact values in a simple circuit such as this.

Kept up so far?

OK, here's a quick quiz to see if you've kept up with us so far. If we increased the resistor to 100kΩ and decreased the capacitor to 470nF, what would the oscillator frequency be?

If you answered about 36Hz, well done. If you had the right digits but were out by several factors of 10, it's time to brush up on your nanofarads, microfarads and Farads! (1nF= 0.000000001F; 1µF = 0.000001F).

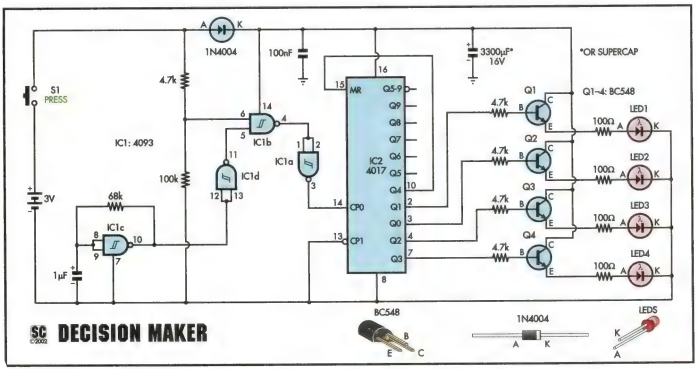
So we have an oscillator running at 26Hz or thereabouts. Its output is a square wave with a "duty cycle" of 50% – that means its "high" state is the same length of time as its "low" state.

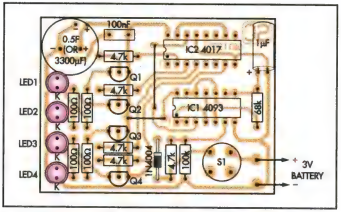
NAND gates

The square wave is fed into a second NAND gate, IC1d (also connected as an inverter) which ensures it is nice and clean. This acts as a "buffer", making sure that any load connected to the gate won't interfere with the charging/discharging cycle of the capacitor in the oscillator.

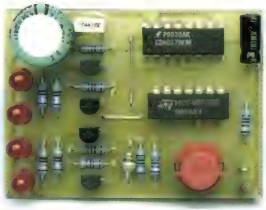
It is then fed into yet another NAND gate, IC1b, this time wired as a true NAND. In a NAND gate, the output will be low only if both inputs are high. If either or both inputs are low, the output will be high.

Here, one of the inputs (pin 6) is connected to the pushbutton switch via a 4.7kΩ resistor. Normally this input is at a logic "low", courtesy of





Everything except the battery is mounted on the PC board. Provision is made for either a supercap or a smaller electro.



And here's what it looks like assembled. This is an early prototype – some components have been moved slightly.

the 100kΩ resistor to earth. But when the pushbutton is pressed, it is taken to a logic "high". When a logic "high" is also present at pin 5 (when the output of IC1d goes high), IC1b's output will go low.

Conversely, when either input goes low (because the pushbutton is released or when IC1d's output goes low) the output goes high.

But IC1d's output (and IC1b's pin 5 input) continues to go high and low, courtesy of the oscillator. While that pushbutton remains pressed, IC1b allows the pulse train through.

Finally, the pulse train is put through yet another NAND gate (IC1a), again wired as an inverter.

To be truthful, this final pulse inversion is not necessary but we had a spare gate in the IC anyway (it's a "quad" NAND gate).

Into the counter

The square wave output from this series of gates is fed to a 4017 decade counter. Now you might be thinking, "how come a decade counter – doesn't that mean ten?" And you'd be right.

But the 4017 is a clever device – it can count to one, to two, to three . . . and so on, all the way up to ten. All you have to do is "reset" it when it gets to the number you want it to count to.

On the circuit diagram, you will note that Q4 (pin 10) and MR (pin 15) are connected. Q4 goes high on the fifth count (after Q0, then Q1, then Q2, then Q3). When Q4 goes high, it tells the reset pin (15) to reset the counter to zero and start all over again.

Those other outputs we mentioned (Q0-Q3) are each connected, via a transistor, to a LED. As each goes high in turn, it turns the associated transistor on, which causes its LED, between emitter and earth, to light.

Because of the speed of the oscillator (26Hz, remember), the four LEDs flash much faster than the eye can follow, so all look like they are permanently on.

How fast do they flash? That's easy: 26/4 or about 6.5Hz. That means that there are six-and-a-half cycles of the lamps each second, faster than the eye can follow.

Incidentally, IC2 has its pin 13 input tied low and its pin 14 input used as the clock input. What this does is make the IC respond to low-to-high logic transistions.

Now, what happens when you let go of the pushbutton?

The battery is no longer connected to the circuit. While there is still a supply line to the counter circuit (courtesy of the charged "reservoir" capacitor), one of IC1b's inputs is isolated from the supply by the series diode. So the pulses stop.

But as we said, the counter section still has a supply, as do the collectors of the four transistors. So that section of the circuit continues working. Whatever output of IC2 that was high at the instant that the pulses stopped remains high, holding on its particular transistor and of course LED, at least for a short time while the capacitor discharges.

So one LED – and only one LED – remains lit. And which particular LED is lit is completely random, depending entirely on when you released the pushbutton.

Due to the fact that the oscillator is running at 26Hz, it is impossible for you to let go the button to achieve a particular result. You would have to be able to not only accurately judge periods of 40 thousandths of a second but also release the button at the exact point in time required. The person who can do that hasn't yet been born!

Table 1: the "truth table" for a NAND gate. Only when both inputs are high is the output low.

INPUT A	INPUT B	OUTPUT
0	0	1
1	0	1
0	1	1
1	1	0

About that capacitor

We mentioned before that a "reservoir" capacitor connected to the supply line charges when the pushbutton is pressed and discharges through the circuit when it is released.

Eventually, the point is reached where the charge is too low to push enough current through the LED, so it dies. You can see this happen: the LED doesn't suddenly go out but gradually gets dimmer.

The time it takes to go completely out depends entirely on the size of the capacitor used to hold the charge. With a 3300μF capacitor, it lasts for a little over a second – just long enough for you to get an answer – but it could be longer! How?

You're probably one step ahead of us by now – with a larger capacitor, of course.

How long? How does 30 seconds sound? We replaced the 3300μF capacitor with a so-called supercapacitor, rated at 0.5F. Yes, that's right – half a Farad, or 500,000μF.

These capacitors are usually used for much the same reason as we use it here – to hold a charge for a short time in the absence of power (eg, when there is a power supply dropout or glitch).

They're not as cheap as "ordinary" electros – probably about $4 each or so – but they really do hold a charge. Whether you want to use one of these or go for the much cheaper 3300µF is entirely up to you – and your pocket.

There is one other "little" problem with using a supercap – it's not so little. You may need to use a slightly larger case to fit it in. But we'll look at this further on.

The 3300µF will normally be rated at 16V while the supercap is much lower – 5.5V is common. But with a 3V supply rail, 5.5V is plenty.

Another thing you could do is use some superbright LEDs in place of the standard LEDs. These are more expensive – perhaps three or four times the price as standard LEDs – but are much more efficient at converting current into light so they are brighter.

Building it

All components are mounted on a single PC board measuring 46 x 63mm and coded 08112021. With the 3300µF electro, it just fits into a small (83 x 55 x 28mm) zippy box, sitting on top of the 2 x AA battery holder, with the pushbutton switch and four LEDs just poking through the top.

With the supercap, you'll need a larger case.

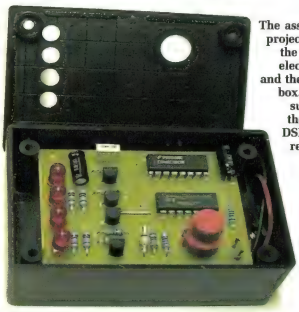
Begin construction by comparing your PC board with the published pattern. These days, problems with commercially-made boards are very rare but it is good practice to check every board before attacking it with your soldering iron.

Solder in the resistors first and use two of the resistor lead off-cuts for the two links on the board. Then put the diode in (the right way around!). Next are the four transistors. The transistors mount down on the board as far as they will go.

These two power supply PC stakes, or pins, can go in now. These actually mount upside-down to the way we normally use them – their longer length goes on the copper side of the PC board. Don't solder the battery connections yet!

Next, solder in the capacitors. First to go in is the 100nF polyester, followed by the 1µF timing capacitor.

Two points to note here: first, make sure you get the



The assembled project, using the 3300µF electrolytic and the Jaycar box. With a supercap the larger DSE box is required.

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Parts List – Decision Maker

1 PC board, 46 x 63mm, coded 08112021
1 plastic utility case, either 83 x 54 x 31mm (eg, Jaycar HB6015) or 85 x 56 x 40mm (eg DSE H2874) – see text
1 SPST momentary action pushbutton switch, PC mounting (Jaycar SP-0720, Altronics S1094 or similar)
1 2 x AA battery holder (with battery snap if required)
2 PC stakes

Semiconductors
1 4093 quad NAND gate (IC1)
1 4017 decade counter (IC2)
4 BC548 transistors (or similar general purpose NPN) (Q1-Q4)
1 1N4001 power diode (or similar general purpose power diode) (D1)
4 red LEDs, 5mm (normal or ultrabrite – see text) (LED1-LED4)

Capacitors
1 3300µF 16VW electrolytic **or** 1 0.5F 5.5VW supercap
1 1µF 16VW electrolytic
1 100nF MKT polyester

Resistors (0.25W, 1%)
1 100kΩ
1 68kΩ
5 4.7kΩ
4 100Ω

electro's polarity right (the "–" goes to the outside of the PC board) and second, leave enough lead length so that it can lie flat on the board. Better still, bend the leads down 90° before soldering it in.

The supply "reservoir" capacitor goes in next. If you are using a 3300µF electrolytic, it goes in the same way as the 1µF timing capacitor (ie, bent over 90°). If you are using a supercap, it goes straight down, as you would normally mount a capacitor on a PC board.

Now solder in the four LEDs, taking care again with polarity. If you are using a supercap, there needs to be a good 3-5mm between the top of the capacitor and the top of the LEDs, so that they can poke through the case lid.

Next solder in the two ICs. Both orient the same way (notch towards the centre of the PC board) but of course they must go in their right spots. When soldering their pins, make sure you don't bridge solder between them. The pins are very close together and it's easy to do.

Finally, solder in the pushbutton switch. It goes in so that the flat on its body runs parallel with the longer sides of the PC board. It can easily fit the other way around but if you put it in like this, all you'll have will be a dead short!

Apart from the battery connections, your board is now complete. Give it a good check to make sure you haven't got any shorts, solder bridges, dry joints, etc.

If everything checks out, solder on the battery leads (but don't have the batteries in place when you do). The black lead is the one closest to the corner of the board.

Checking it out

The only easy way to check it out is to use it! Pop the batteries into their holder (the right way around). Hopefully, absolutely nothing happens (ie, no LEDs light). If they do, you have a short somewhere.

Now press the push-button switch – all the LEDs should come on together. So far, so good. Let the switch go and hopefully one LED is on and all others are off. Wait a while (depending on which capacitor you've used) and the LED should dim and die.

If so – it's finished, apart from mounting it in its case.

A good case

If you've used the 3300µF capacitor, the board should fit inside the Jaycar HB6015 jiffy box (or similar) with the battery holder underneath.

If you've used a supercap, it's likely that it will be just a smidgeon too high, meaning you won't be able to get the lid on!

Fortunately, there is an alternative box, the Dick Smith Electronics H-2874, which is 40mm high (compared to 28mm high). So that will give you all the clearance you need.

But remember that the LEDs will need to be mounted higher and you may even need to mount the push-button switch on tiny "stilts" (resistor pigtail offcuts are ideal).

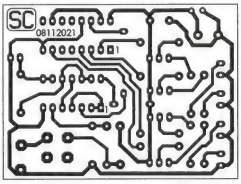
The front panel label will fit either box – glue the label to the lid and drill your holes to suit.

If you find the board slops around inside the case, put a small piece of foam plastic between it and the battery holder to force it right up against the lid.

Decision time . . .

Now, there's a decision to be made. Do I use the supercap or smaller capacitor?

Gee, I wish I had something to help me decide! **SC**



Same-size artwork for the PC board and front panel. When you photocopy the front panel, make two copies and you can use one as a drilling template.

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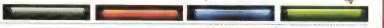

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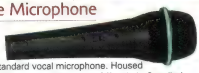

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Cat. AM-4086 $46.95

Soldering Kit

Designed for general purpose soldering. Includes our Duratech 25W 240V soldering iron, a quality metal stand with sponge, a length of solder, and a desolder wick. A great starter pack for enthusiasts.

Cat. TS-1650 $31.95

Volt, Temp, Clock for Cars

This stylish display features a cool EL backlit LCD, battery voltage, in/outside temp. time and date. See cat P328 for details.

Cat. XC-0116 $39.95

My First Clock

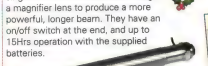
This clock is designed to stimulate a childs curiosity and their desire to learn and explore.
By combining the parts you create a fully operational clock, installing the colour coded gears into the transparent casing, children can then see the workings of the clock.
For ages 6 and above.

Cat. XC-0113 $24.95

Aluminium Torches with a Magnifier Lens

NEW PRODUCT!

Made from polished aluminium, they feature a Titanium look finish, and a single LED which is focused through a magnifier lens to produce a more powerful, longer beam. They have an on/off switch at the end, and up to 15Hrs operation with the supplied batteries.



150mm Long Handheld

Cat. ST-3324 $29.95

90mm Long Key Chain

Cat. ST-3322 $22.95

PC Multimedia Speakers

Mains powered, they feature solid bass reflex cabinets with volume control and sound great. Ideal for games and multimedia production.

Cat. XC-5160 $23.95

Turbo Camping Shower

Add a touch of luxury to that outback adventure. Use a bucket of warm water, and your vehicles battery, and enjoy a shower no matter how far from civilisation you are.

Cat. YS-2800 $27.50

Vulcan 100 Gas Soldering Iron

Runs on standard butane gas, it fills in 20 seconds

and will run up to 90 minutes on one refill. It is temperature adjustable (equivalent to 10-120 watts)
•See Cat Pg 205 for details and the spare tips available.

Cat. TS-1250 $49.95

IR Wireless Mouse

A cable free mouse will eliminate short and tangled mouse cables forever. Features wide transmission angle and battery saving "sleep mode".

Cat. XM-5118 $39.95

Universal Preprogrammed Remote Control

Replace old remote controls. This versatile 5 in 1 remote will control up to 5 devices and is preprogrammed for over 25000 different pieces of equipment.

Cat. AR-1709 $39.95

Auto Ranging DMM

Accurate and simple to use! Once the electrical value is chosen, i.e. volts, current etc. the meter selects the most appropriate display range. See Cat. page 180 for Impressive features and specs.

Cat. QM-1535 $39.95

CD-R Labelling Kit

Make Professional quality CD labels with the comprehensive design software and labelling machine. Kit includes CD labelling machine, pack of 50 labels and CD ROM design software.

Cat. XC-4784 $49.95

CD-R Label A4 Refill Pack - Pk.50 labels

Cat. XC-4785 $19.95

32 Pocket DVD Wallet

NEW PRODUCT

Here is a compact & convenient way of carrying your valuable DVD collection from place to place. The zippered wallet has a soft leather look finish and has a secure carry loop on the spine.
Measures approx 230 (W) x 245 (H) x 70 (D)mm

Cat. AR-1491 $39.95

GSM SIM Card Reader

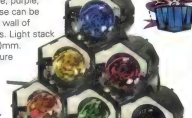
An easy way to store, share, print and manage the phonebook and text messages from your mobile phone via your PC. Connects via the serial port, and is supplied with software.

Cat. XC-5100 $39.95

Can't decide on a gift?
Give a Jaycar Gift Voucher and they can choose it themselves!

Mini Linklamp Party Light

This six light set uses special metal filament bulbs, which heat up, then switch off, cool down and turn on, and the cycle continues. So you end up with 6 different coloured globes all going on and off by themselves. No expensive controlling circuitry to buy. Globe colours are red, blue, purple, yellow, green and orange. These can be linked together to form a large wall of random flashing coloured lights. Light stack size is 250(W) x 240(H) x 75(D)mm. Spare globes available - miniature edison screw base.



SPARE GLOBES:
Red SL-2993, Green SL-2994, Blue SL-2995, Yellow SL-2996, Orange SL-2997, Purple SL-2998

Cat. SL-2992 $49.95

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Stocking Fillers for Under $20.

Data Hold DMM

A full feature digital multimeter with data hold and a 12 month replacement warranty if the unit has a fault. See Cat Pg 180 for impressive specs and features.

Cat. QM-1520 $19.95

24 & 96 CD Carry Wallets

The compact way to carry your CD's. They feature non-scratch inserts, and a tough exterior with a zipper to close it up. Colours available are Red and Black.

NEW-PRODUCTS

24CD Cat. AR-1483 $5.95ea

96CD Cat. AR-1484 $19.95ea

Power Driver Bit Sets

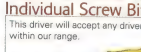
2 different sets to choose from, both contain 32 driver bits to suit the not-so-common security screws. See Cat Pg 206 for a full list of whats inside.

Tri-wing, torx, pin drive, hex, and torque set Cat. TD-2035 $14.95

Clutch drive, square drive, hex, torx and slotted Cat. TD-2036 $13.95

Blank Hex Driver for Individual Screw Bits

This driver will accept any driver bits within our range.



Cat. TD-2032 $5.55

6" Light Sticks

...u've all seen them before, probably ...t at this great price! Keep the kids ...rtained after dark this summer. ...ctive chemicals in our light ... are non-toxic and non- ...able. There are 5 colours ...e and last up to 8 hours.

Red
Yellow
White
Blue
Pink

All colours $2.50 ea

Keyring Screwdrivers

Consists of a 5mm slotted and #2 phillips driver, and is small enough to hang on your keyring.

Cat. TD-2012 $2.95

Miniature AA Ni-Cad & Ni-Mh Battery Charger

Convenient and small size, plugs directly into power socket and will charge 2 or 4 AA batteries. Charging indicator shows that the batteries are inserted the correct way and are charging correctly.

Cat. MB-3530 $18.95

12V Auto Work Light

Plugs directly into your cigarette lighter socket for easy connection, supplied with a 4.5m lead. A must for every mechanic.

Cat. ST-3032 $16.75

Super Bright LED Keyring Torches

They use high brightness LED's and draw very little power, while providing an intense bright light.

Cat. ST-3044 Red $9.95
Cat. ST-3046 Yellow $9.95
Cat. ST-3047 Blue $14.95
Cat. ST-3048 White $14.95
Cat. ST-3049 Green $14.95

Sparkplug Keyring LED Torches

Looks just like a sparkplug, but twist its body and its a powerful LED torch.

Cat. ST3068 White LED $14.95
Cat. ST-3069 Blue LED $14.95

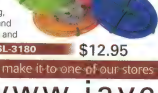
Keyring Super Bright White LED Torch

This robust aluminium torch features 'O' ring seals for good water resistance and a single super-bright white LED, for bright, long lasting light. Features rubber grips, spring loaded carabineer key ring, and batteries included.

Cat. ST-3072 $19.95

Cool Tubes

When we saw this fantastic black-light sensitive tubing, we were amazed at the variety of uses people came up with. Make signs, masks, theatrical props etc, and when placed near a black-light, they will glow like neon. Kit comes complete with 4 x 1.5m rolls of coloured tubing, shaping wire, and dozens of clips and toiners.



SL-3180 $12.95

LED Glowlight Pens

Attractive and stylish, they not only write, but incorporate an LED so you can see what your writing even in complete darkness.

ST-3065 Red $9.95
ST-3066 Blue $11.95
ST-3067 Green $9.95
ST-3071 White $11.95

UV LED Glowlight Pen

Similar to the pens above, though with a UV LED, and protective end cap.

Cat. ST-3063 $14.95

Ultraviolet Super Bright LED Keyring Torch

This model produces a bright UV light for fun at nightclubs, or to check watermarks on most international currency and credit cards.

Cat. ST-3043 $14.95

Stereo Backphones

NEW PRODUCT

Unlike traditional headphones, these lightweight headphones clip over your ears and comfortably rest on the back of your neck, making them ideal for sports activities like jogging, cycling, skateboarding, etc.

Cat. AA-2050 $14.95

Piezo Pocket Gas Torch

Handy pocket gas torch with piezo ignition. Great for camping, heating small objects and camping etc. Refill with standard butane gas (NA-1020)

Cat. TS-1662 $14.95

Keyring Laser Pointer

Fully approved laser pointer with <1mW output and powered by 3x LR44 button cells. Supplied with batteries and key-chain clip.

Cat. ST-3102 $12.95

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SurfCam Web Camera

Send pictures and video to your friends via email. Uses a 100k pixel CMOS image sensor. Supplied with editing software.

NEW PRODUCT

Cat. QC-3220 $49.95

Mini USB Optical Mouse

A compact companion for a Notebook or PC.

NEW PRODUCT

Cat. XM-5126 $39.95

CD-R/RW Singles

Mitsui 80min CD-R
Cat. XC-4709 $0.99

CD-RW
Cat. XC-4723 $2.95

90min CD-R
Cat. XC-4725 $1.35

USB Flash Memory

NEW PRODUCT

One of the most portable storage devices yet! Simply plug into a USB port and you have a removable data storage medium. No drivers are required (except Win 98/SE) Lightweight and portable. Ask in store for details.

32Mb	Cat. XC-4763	$99.95	NEW
64Mb	Cat. XC-4764	$139.95	NEW
128Mb	Cat. XC-4765	$189.95	NEW

Four Port USB 2.0 High Speed Hub

NEW PRODUCT

Conforms to USB 2.0 spec. Transfer rate up to 480Mbps. Plugpack supplied.

Cat. XC-4821 $79.95

Gifts to compliment that new computer

CD-R Bulk Packs

20Pk
Cat. XC-4710 $13.95

50Pk
Cat. XC-4718 $28.95

100Pk
Cat. XC-4726 $54.95

USB Data Extension Cable

NEW PRODUCT

Active USB Repeater Cable. 5m long

Cat. XC-4839 $34.95

PC Security and Encryption Key

This system uses a hardware 'key' that plugs into your USB port, and in conjunction with the supplied software give complete security control. Ask in store for Details.

Was $399, Save $70
Cat. XC-4838 Now $329

InfraRed USB Converter for Mobile Phones

NEW PRODUCT

Transfer and edit information between you PC and you IR compatible mobile phone.

Cat. XC-4831 $79.95

Home Unit Subwoofer 30WRMS 6.5"

Solid bass enhancement to your home theatre system.

Cat. AA-0512 $169

2 Input Stereo DJ/Multimedia Mixer

Mix 2 channels to 1. Features level indicators, channel level and cross faders, cue and mic level controls. Plugpack included.

Cat. AA-4205 $99

4 x 100WRMS Car Amplifier

A powerful addition or a perfect start to your car stereo system.

RESPONSE

Cat. AA-0435 $449

6.5" XL RESPONSE Split Speaker / Coaxial Combination

The adjustable 20mm dome tweeter mounts on the woofer just like regular coaxials, though with a quick twist, you can remove the tweeter and mount it separately. Supplied with 2-way crossovers and wiring. Power handling 60W max (40WRMS). See Cat P253.

Cat. CS-2296 $119

Excellent additions to a home or car stereo installation

Car Super Tweeters

Add extra treble to your system. 40WRMS handling and sound great!

Cat. CS-2218 1+ $7.95ea 4+ $6.95ea

UHF Wireless Stereo Headphones

These 433Mhz wireless headphones incorporate the latest RF technology to provide personal listening freedom with great sound, and a range up to 50 metres. The supplied 2 x AA NiCad rechargeable batteries powering the unit, can be charged by plugging the headphones into the transmitter when not in use. See Cat P247 for specs.

Cat. AA-2000 $109

Venom Subwoofers

Excellent performance at a very competitive price. See Cat Pg 255 for Details.

8" 100WRMS
Cat. CS-2340 $49.95

10" 150WRMS
Cat. CS-2342 $79

12" 180WRMS
Cat. CS-2344 $

15" 250WRMS
Cat. CS-2346

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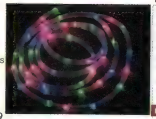
ICE Ropelight

Four colours, red, yellow, blue and green set in a frosted plastic 'rope' 17mm dia, and 10m long. The translucent effect is like lights under ice. Comes with a dedicated controller with 8 distinct effects.



2001 Price $68.95 Save $19

Cat. SL-2820 2002 Price $49.95

3 Way Linkable Light

Great for parties and disco effects, this modular lighting system consists of 3 stackable lights and a matching controller that responds to ambient music levels. Individual light modules support coloured R80 60W spot lamps with an Edison screw base. All modules are hexagonal, ~140mm across and are 150 mm deep.

Includes 3 globes

Was $129 Save $15

Cat. SL-2950 $114

Replacement Globes $7.80ea

Orange Cat SL-2953
Purple Cat SL-2954
Red Cat SL-2955
Green Cat SL-2956
Blue Cat SL-2957
Yellow Cat SL-2958

Additional Linkable Light Module $22.50ea

Cat. SL-2952
Globes extra.

Mirror Balls

Just what you need to add a bit of life to your next party. Use with one or more of our PAR 36 pinspots for an amazing light effect. See Cat Pg 307 for details.

8" Ball
Cat. SL-2980 $24.95

12" Ball
Cat. SL-2982 $39.95

12" Coloured Ball
Cat. SL-2981 $49.90

Mains Powered Mirror Ball Motor
Suitable for 8" & 12" mirror balls.
Cat. SL-2984 $24.95

For every party these holidays

Mini Strobe Light

Bring new life to any party, has an adjustable flash rate up to 10 flashes/second.

Was $38.95

Cat. SL-2990 $29.95

Par 36 Can Light

Includes mounting bracket and 240V-6V transformer. Globe not included. (Use our Cat. SL-2964 $9.95). See Cat P309 for details.

Cat. SL-2960 $37.95

New Low Price on Fog Machine

Create dramatic effects for theatrical productions, parties, discos, entertainment venues!
Was $139
Save $50

Low Price $89

Cat. AF-1200

Party Speakers

Great sound at an excellent price. See Cat Pg 235 for Details. Techstore shoppers – may incur an additional freight charge ask for a quote first. Price per unit.

15" shown

12" 100WRMS
Cat. CS-2512 $159ea

15" 120WRMS
Cat. CS-2515 $209ea

8" Mirror Ball Set

This party kit contains everything you need to create your own disco at home. Kit includes 20cm ball, rotating stand, par 36 bulb, and 4 colour filters.

Was $99
Save $10

Cat. SL-2983 $89

Non-Contact Digital Thermometer with Laser Sighting

Take a remote temperature reading of any objects without touching them. Features a laser pointer to ensure accurate targeting of far away objects.

Cat. QM-7220 $149.50

40 Channel UHF Communicator

This high quality pocket transceiver works on the UHF band and gives an open field range of up to 5km and an inner city range of up to 1km with just 0.5W output, and even greater range with its repeater function. A hands free VOX kit and battery-charger are available.

Cat. DC-1010 $79.95

Hands Free VOX Kit to Suit Above
Cat. DC-1012 $14.95
Mains Charger to Suit Above
Cat. DC-1014 $14.95

Anti-Static Soldering Station

Excellent temperature stability and anti-static characteristics make this soldering station a must for hobbyists and professionals. Backed with a 1yr warranty. Made in Japan.

Cat. TS-1440 $269.95

Battery Powered Soldering Iron

Powered by just 3 x 1.5V batteries (not included), and heats up in minutes. The ultimate in portable soldering.

Cat. TS-1286 $74.95

Gifts for the hobbyist and professional

100W Soldering Gun with Pilot Light

Heats to temp in seconds, great for fast or tough jobs.

See Cat Pg 198.

Cat. TS-1425 $24.95

11 Piece Cellular Phone Toolkit

Includes essential tools to access the internals of mobile phones.

Cat. TD-2024 $29.95

Mini DMM

A full function DMM for under $10!

Cat. QM-1498 $9.95

Backlit DMM

With a touch of a button, the LCD screen is backlit. Perfect for low light conditions.

Cat. QM-1522 $26.95

10MHz Velleman Personal LCD Handheld Oscilloscope

NEW PRODUCT

The Velleman Personal Oscilloscope is a complete portable unit at the size and cost of a good multimeter. It's an ideal oscilloscope for hobbyists, students, service people, automotive applications and general development. Features include a high contrast LCD with wide viewing angle; full automatic setup for volt/div & time/div; true RMS and dB measurements, screen hold function; low battery detection and auto power off. Ask in store for full details.

Cat. QC-1916 $349

6 Piece Precision Tamper Torx Set

Chrome Vanadium Drivers. Includes T7,T8,T9,T10,T15,T20, all in a felt lined case.

Cat. TD-2021 $17.95

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LED Santa Display Kit

Available through Techstore Mail Orders Only
Not available through Jaycar Retail Stores

Enhance your Christmas spirit with this exciting LED display kit. The kit uses over 600 high brightness LED's to create a colourful and eye catching display which measures almost 1 metre across. See Cat page 19 for details. Limited Quantity.

Techstore Mail Orders Only

Cat. KC-5302 $169

MicroMitter Stereo FM Transmitter Kit

Refer: SC Dec 2002.
Earlier versions of this stereo transmitter kit were first introduced in1988. This model was followed up with Minimitter MkII in April 2001. Improved on these models further, is the Micromitter. It features a more compact and stable design than its previous models using a surface mount BH1417F processor. Supplied with PCB, Case, Silk Screened Front Panel and all electronic components.

NEW PRODUCT

Cat. KC-5341 $39.95

Available Late December

32 LED Christmas Tree Light Display Kit

This ever-changing light display is perfect for the top of the Christmas tree this year. This microprocessor-based project generates several different patterns on 32 Bi-coloured LEDs, pulsing them between red, green and orange. See catalogue page 19 for details.

Cat. KC-5280 $59.95

Dynamic LED/Christmas Star Kit

This micro-processor controlled array of 30 LEDs creates a number of different eye catching patterns. See cat. page 19 for details.

Cat. KC-5253 $36.95

OUR LATEST KITS

AVR ISP Serial Programmer Kit	SC Nov 2002	Cat KC-5340	**$45**
5-Amp Mains Motor Speed Control Kit	SC Nov 2002	Cat KC-5339	**$55**
12V Inverter Kit for 40W/240V Fluoro's	SC Sept 2002	Cat KC-5338	**$99**
Driving Light Protector Kit	SC Sept 2002	Cat KC-5337	**$24.95**
Headphone Amplifier Kit	SC May 2002	Cat KC-5335	**$19.95**
Multi Mode Timer Kit		Cat KD-6017	**$42.95**
12V Battery Guardian Kit	SC May 2002	Cat KC-5334	**$39.95**
Itsy Bitsy USB Light Kit	SC Mar 2002	Cat KC-5328	**$12.95**
10 Channel IR Remote Control Receiver Kit	SC Feb 2002	Cat KC-5326	**$49.95**

Ideal Christmas Gifts For The Kids

These kits are designed to help experimenters understand the fundamentals of DC circuits, motors, generators and bells. Great fun for ages 10 and up. Each includes a light kit as a bonus!

Motor/Light Kit
•2 kits in 1
•Includes bonus light kit.

Cat. KJ-7042
$19.95

Generator/ Light Kit
•2 kits in 1
•Inc. bonus light kit.

Cat. KJ-7044

$19.95

Bell/ Light Kit
•2 kits in 1
•Inc. bonus light kit.

Cat. KJ-7040
$19.95

AM/FM Kit
Build a real AM/FM radio.

Cat. KJ-7048
$29.95

LOOKING FOR AN OLD KIT?

If you are, we may have it in our Kit Back Catalogue. The 'Kit Back Catalogue' range is listed on the Jaycar website (under Kits & Projects) and can only be purchased via the website 'www.jaycar.com.au' or Techstore (i.e. not the Jaycar stores).

STORE LOCATIONS / CONTACT NUMBERS:

All prices valid to end December 2002

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EMAIL ORDERS: techstore@jaycar.com.au

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Post $25 to $49.99:	$5.50
Post $50 to $99.99:	$7.70
Post Over $100:	$8.80

Road Freight Anywhere In Australia (up to 20kg): $15.50
Express Post Max 500g: $7.70
Express Post Max 3kg: $11.00

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•Max weight 3KG (inc cubic) $11 •No dangerous goods
•Max weight 5kg (inc cubic) $16.60 •Stock & availability
•Orders must be received before Midday E.S.T.

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•140 Campbell St. Hobart
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•266 Sydney Rd •Ph: (03) 9384 1811
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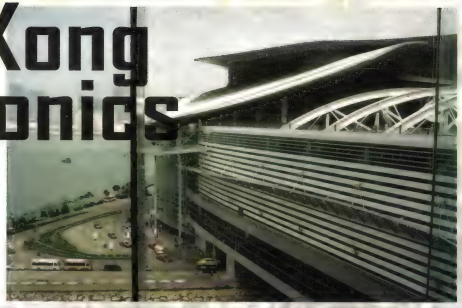
Hong Kong Electronics Fair: the biggest ever



This photo does NOT show the exhibition centre: it shows a part of the exhibition centre from another part of the exhibition centre!

This year's Hong Kong Electronics Fair, held from October 11th to the 18th, was the biggest ever in Asia. It was combined with the Hong Kong International Lighting Fair and electronicAsia which concentrates on electronic components such as SMDs, capacitors, switches and so on.

The venue for the combined show is truly vast, with 44,000 square metres of space spread over three levels. With thousands of exhibitors, the exhibition floors were like a maze. So much so that it would take several days to examine everything on show. Indeed, many visitors did just that.

This year's show was so big and so many potential exhibitors were turned away that next year's show will split off the Lighting Fair to make more space for the electronic product exhibitors. Total number of exhibitors at the HK Electronics Fair and electronicAsia amounted to 2253.

Total attendance over the four days was almost 86,000 people and the vast majority of these were buyers (ie, mostly buying representatives from large retailers and distribution companies) from overseas countries. Australian buyer attendance was up 43% from last year, coming in at 11th place. As a buyers' show it was quite different from consumer electronics shows we have had in Australia. At the HK show, the attendees were trade visitors only.

The range of electronics products on show was truly immense, with everything from reproduction vintage telephones, a bewildering variety of consumer electric and electronic products, to car sound, home theatre, musical instruments, IT products and so on.

The vast majority of the companies on show would be unknown to Australians, with many coming from China's rising power-house of electronics in the Pearl River delta (centred upon Shenzen city). In this area of China alone, there are over 10,000 electronics manufacturing companies, employing millions of people. No wonder there is such ferocious competition in the world electronics market.

Of all the vast products on show, two stood out in retrospect. The first was a home theatre system from Nakamichi which had very tall speakers with inbuilt elevators to alter the driver height, to optimise your listening experience. And the second? Surface mount LEDs that were so tiny and bright that they were quite painful to look at closely.

And while most of the products on show represented multiple variations of devices that Australians are already widely familiar with – DVD players, compact music systems and so on – the overall impression was that quality standards are continuing to rise rapidly while prices are generally static or even falling.

Next year, the Hong Kong Electronics Fair promises to be even bigger, as they continue to showcase the giant and growing electronics industry of Asia and particularly China. **SC**

Just finding your way through the huge crowd was a feat in itself . . .

Nakamichi speakers with inbuilt elevators to alter the driver height!

Don't be surprised to find "antique" phones in your stores shortly . . .

SERVICEMAN'S LOG

A shame about the Shamrock

It happens every now and then – a lot of time is spent on a particular job, real progress is made and then you can't complete the job for lack of vital information. Such was the case this month with a model SRC2102L Shamrock monitor.

The 1994 51cm Shamrock Tech monitor (SRC2102L) had been lying around in a corner of the workshop almost forever. It came in as dead and although I spent a lot of time on it, I really needed a circuit. Unfortunately, after a lot of searching, I couldn't find one. I was about to send the monitor to the tip but its size and weight started the inertia and its good looks made me spare it.

Weeks spread into months and about 18 months later, I finally heard about one in a mate's workshop. His model, though identical, was in fact nearly a year younger in production (1995) and had an entirely different fault – intermittent no video – which he had been able to fix (it was a faulty joint). I asked if I could borrow it for a while to compare notes and he agreed.

The power supply is a twin switchmode unit and I assumed it had failed due to failure of the horizontal output transistor Q609 – actually two transistors in parallel. But I had no way of knowing whether this parallel arrangement was the manufacturer's design or a bodgie repair.

The transistors fitted were 2SC5084, which are rated at 1700V, 12A. However, my friend's monitor had only a single transistor which was much larger – a 2SC5144, rated at 1700V, 200W and 20A. I had no idea where one can buy these devices but it was the most powerful horizontal output transistor I had seen to date. Despite the much lower rating, I refitted only one 2SC5084 before turning my attention back to the power supply.

From examination and measurement, I diagnosed Q102, R105, C144, C145, C134, Q108, D107, C120, C121, C125, C128, U101 and U102 as being faulty, and all were replaced. R105 was so badly burnt I couldn't read it at all (another reason I had left the repair on the side for so long) but now that I had one to compare, I could see it was 0.56Ω. The original FET, a 2SK1723, wasn't available so I substituted a 2SK1940 (600V, 12A, 150W).

By now I was beginning to have some success. Half the power supply was working but I was not getting 50-120V on CN104-5.

The power supply module is separate and doesn't take too long to remove. I compared mine with my friend's and could only detect small differences to begin with, so I thought it was worth plugging his power supply into my monitor.

The only problem was that one plug had a blue lead which mine did not have. No worries – I sorted this out to be a re-routed 25V rail from (presumably) the horizontal output transformer and this just involved inserting a link.

Refitting my friend's power supply into my monitor brought encouraging results. The monitor fired up but gave a picture with insufficient height. The bad news was that there was lots of smoke coming from the vicinity of the horizontal output transformer but I couldn't find the source before it stopped.

(This only confirmed what I have long suspected – that all components are made of smoke. When the component fails, the smoke is released!)

Well, at least the rest of the monitor was more or less OK. And I felt confident that with that amount of smoke, I would soon find the offender.

Back to my power supply – the original D107 was an SB130, so I substituted a 1N5158. I noticed that pin 5 of U105 had a link to C124 on the later board but more disturbingly, Q104 (FOR3G) looks like a PUT (Programmable Unijunction Transistor) and two of its three leads were reversed from one board to the other. There were other small changes as well but mostly in AC mains filtering.

Fortunately, during my detailed examination, I found that R122 was open circuit. A new 0.33Ω 3W resistor resulted in my monitor firing up. Not only that, but it gave a full-height picture (unlike with the other power supply) – and no smoke! I refitted his power supply into his set and checked that it was still OK, which it was.

So everything appeared to be functioning normally and looking pretty good, at least in the short term. But there was still a problem – this monitor did not appear to have any pincushion correction circuitry of any kind.

I spent a long time trying to work out where the pincushion circuit was but was unable to find anything. I cannot find any marked pincushion control, although I found width, trapeze, parallel and other controls. I

Items Covered This Month

- Shamrock SRC2102L Tech. monitor.
- Panasonic TC-29V26A TV set (M16MV30 chassis).
- Polytron Grand Master 34cm TV set.
- JNL Digi-vision TV set (model JNL5103).
- Diesel generator control boards.

also checked most diodes and power transistors in the hope that they were in the east/west output circuitry but got nowhere.

Normally, in a conventional TV set, one would expect two east/west modulator diodes feeding a power transistor and the deflection yoke with horizontal pulses, while vertical pulses create a butterfly waveform. In computer monitors, because of the multiple scanning frequencies, this circuit can get horribly complex, with a selection of FETs for each configuration.

So, for now, the Shamrock monitor is back in the corner, until I get some more inspiration from another source. Does anyone out there have a circuit? Please!

Panasonic

I have just had another Panasonic M16M chassis TV set come into the workshop. This chassis was very popular due in part to the fact that its production run was much longer than almost any other modern TV set I have encountered. The first sets were produced in late 1991 and the last were still being sold in 1997, six years later.

That said, there are many subtle differences between the early and late models and these are to be seen in the M16MV30 chassis. Outwardly they all look identical but, for example, the on-screen menus and special effects are much more complex in the later EEPROM software.

This particular set, a TC-29V26A, came in with the complaint that "it intermittently wouldn't tune in stations". More correctly, in the AUTO or MANUAL tuning modes, the tuning wouldn't stop when it encountered a station onto which it would normally lock.

This sort of fault is usually much too hard to fix in the home. It normally involves the AFT circuits to the tuner but can also involve microprocessors and EEPROMS. But I was comfortable about tackling this one in the workshop, especially as I still had on hand the disastrous one with the broken tube I wrote about in the July 2002 issue. (You will be pleased to hear this is still performing faultlessly as a test monitor).

I started by examining the set with its back off. Immediately, I encountered confusion. The back clearly stated the set to be an M16M chassis and yet all the boards inside were for the later M16MV30, so I assumed that the set was actually the latter.

I started by changing the usual 330µF troublemakers – C885 and C889 – in the 5V power supply. I also spent some time soldering any potential faulty joints, including some around the jungle IC (IC601, TA8719AN).

That was my first big mistake. I don't quite know how I did it but I had committed TV murder – the set was now completely dead. Half an hour later, I worked out that I had somehow damaged the jungle IC and it was no longer giving out sufficient horizontal drive to the output stages from pin 39. A new 64-pin monster restored the sounds and lights but did not fix the original tuning fault.

To localise the problem, I decided to replace the tuner/IF module – PCB type B (TNP107925) – in the faulty set with the one in my set. The only problem with that was they were completely different. The module in the faulty set (TNP107925) was quite a small module – it was rectangular, double-sided and carried a sub-module (stereo decoder – TNP107926). By contrast, the board (TNP107764AG) in my set was trapezoidal in shape, much bigger and single sided.

I knew I was probably tempting fate by changing them, especially as the AV panels were also completely different and looked to be interrelated. Fortunately, my fears were unfounded and the board was easily substituted. This isolated the tuning fault to this one module.

So all I had to do was fix the board and that was easier said than done. I could actually tune the set properly if I was prepared to hold the fine-tuning buttons long enough and the tuning would lock onto memory.

The main issue was that the tuning wouldn't stop in the MANUAL or AUTO tuning modes. This meant that in the NORMAL mode, the AFC output from pin 12 of IC101 would be fed to the AFC input (pin 6) of the tuner, as well as Q102, IC1206 and IC1213.

In the NORMAL mode, it looked as though it really was working OK, except that occasionally I noticed it didn't quite lock on. I wasn't sure what significance to put on that,

though. Alternatively, in the TUNING modes, the AFC output is deleted, and a preset bias of 6.5V is applied to the tuner from the OFFSET Control (R113.)

The tuning process is stopped and stored in memory by the presence of sync pulses to pin 7 of the microprocessor. However, I found this to be extremely confusing, because it was the stop signal that was absent, even though sync pulses were available.

I set up the AFC alignment by linking the tuner IF output to chassis and switched IC102 high by linking TP-B19 to TP-B2 (12V). I then tried setting the AFC pin (pin 6) of the tuner to 6.5V with R113 (AFC offset) and TP-B91 (the AFC output to the microprocessor) to 2.5V with R144. The only trouble was that this latter adjustment would not go much beyond 1.2V.

Eventually, I concluded that it must be the AFC switching IC (IC102, HEF4066) that wasn't working properly, so I dutifully changed it. I was wrong, of course.

I then spent a lot of time measuring components all around R144 and Q102. Finally, I measured the AFC output from pin 12 of IC101. This should be 5.1V but I was getting less than 1V. Naturally, I switched my suspicions to IC101, which is AN5179AK 30-pin high-density IC. The problem was that my board had an AN5179K – was this significant? To cut a long story short, I decided to restore the original tuner set-up first, in case the gain was low.

I unsoldered the screening covers around IC101 and noticed immediately that there was some corrosion from a leaking electrolytic capacitor – probably C167 (470µF 6.3V). I cleaned up the mess and replaced C167 and C122, plus C113 for good measure, but this made no difference. The old capacitors all measured OK too.

I then changed IC101 but there was still no difference and there was now not much left I could do. Grasping at straws, I decided to measure the voltages on all the pins of IC101 and compare them with the voltages on the other good board.

Quite a lot were out but the two significant and important measurements were pin 12 (AFC out) and pin 18, the AFC V_{CC} input (12V). The former I already knew about but the latter was extremely low (about 2V) and, of course, is vital for the AFC to work.

So, the 12V was not being applied to pin 18 from TP-B2. But following its path wasn't easy because of the double-sided tracks on the board. In the end, I followed a very convoluted path on both sides of the board until I found that the voltage was missing right where the board had been discoloured from the leaking capacitor electrolyte.

In fact, it was the printed circuit feed-through connection that was open circuit. A new wire link and another AFC realignment fixed the problem properly. All I had to do then was replace all the parts I had filched from the other set.

An unusual set

An interesting and unusual set arrived on my workbench recently. It was modestly called a Polytron Grand Master and is manufactured by PT Hartano Istama Electronics in Kudus, Indonesia. The reason why this set was interesting was because of its small size (34cm) and large list of features. It was the only full stereo teletext set I had seen in this size and it was fully optioned with on-screen menus and AV inputs.

Anyway, the problem with the set was a dark vertical line down the centre of the screen from top to bottom, with the picture on either side. In other words, the picture was locked with the edge in the centre. I checked the horizontal hold (RT403) and horizontal centre (RT402) controls and set them up properly but that wasn't the cause. To me, it seemed that the horizontal AFC circuitry from the horizontal output transformer to IC402

(TDA2579) was faulty.

Next, I connected the CRO to pin 4 of the horizontal output transformer. There was a mass of signal here but it had all disappeared by the time it reached pin 12 of IC402. There were just two components to check – C436 and R449 (68kΩ). The latter had gone very high and a new one fixed the problem.

Another unusual set

Another unusual set was a JNL Digi-vision TV (model JNL 5103). This was a Chinese-built TV set about two years old and it was very dead.

Opening it up revealed that the switchmode power supply had blown, with five electrolytic capacitors on the verge of exploding. In fact, they had already spilt electrolyte all over the board and corroded the copper tracks and some of the components around them.

Replacing FA501, V513, V511, V512, C552, C562, C559, C5673, C557 and cleaning up the corroded mess restored the picture. I checked the main HT on C563 to be 110V. There was still no sound and that was traced to R910 1Ω being open circuit and the two output ICs (N701 & N711, CD5265CS).

The picture and sound are great now but one has to wonder why a set only two years old had failed like this.

And now for one of the contributed articles which I mentioned last month. As before, it provides a complete change of scene; something unlikely to be encountered in normal run-of-mill service situations. Again, this is from J. B. of Hampton Victoria and this is how he tells it.

Who goofed?

A work colleague recently asked me to have a look at a couple of circuit boards. He said they were from a diesel generator on a boat. Both units had failed and they were $800 dollars each to replace. He indicated that the owner had previously had one fail and that the replacement had also now failed and it was getting too expensive to go on replacing boards.

If I could repair them and shed some light on the cause of the failure, it would be appreciated. I had a quick look and the board was approximately 120 x 80mm and contained an LM339, an LM2917, an opto-coupler, a dual relay, a number of discrete components and some screw terminals. My first thought was how could $20-30 dollars worth of parts be sold for $800?

My colleague was unable to provide a circuit diagram or any information about the controller. However, he was able to provide a wiring schematic showing how the controller was connected to the generator set. Searching the manufacturer's website gave no service information.

So how do you fix something when you don't know what it does? With the aid of a cup of coffee, I started to trace out all the external connections and attempted to work out what was supposed to happen. The LM339 is a comparator, so there was unlikely to be very much in the way of complex logic to understand.

I soon worked out that terminal 1 was connected to the battery (12V) and that terminal 2 was chassis. Hooking up some power confirmed that the module

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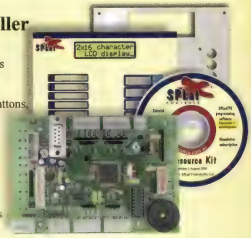

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was quite dead – there was no sign of power being applied to the LM339. This turned out to be normal; the power supply is enabled only when the board is in start and run mode but I didn't know that at the time.

Terminal 3 was the generator start switch and needed to be connected to chassis, while terminal 4 was the stop switch. Connecting terminal 3 to chassis had no effect. Reasoning that there should be a pull-up on this terminal, I found that I had only 0.3V, so there were a few volts missing! This was traced to a 10Ω resistor (R37) that was now several MΩ.

Replacing the cracked and over stressed R37 now gave me some signs of life but I now had a standing current of around 50mA. This would flatten the battery smartly, as it was connected to the battery at all times. The cause of this over-current was CR10, a 39V zener (1N4754) which was found to be conducting at about 8.5V. Replacing this with a new 1N4754 fixed the standing current problem.

It should be noted that both the original R37 and CR10 parts looked OK on the board. It wasn't until they were removed that I could see signs of stress. In addition, R32 (1kΩ) was cooked and a red LED had its top missing. These parts were also replaced.

The remaining terminals on the board connected to the starter motor, alternator field, a switched 12V output and an input where all the safety devices are connected. This input is pulled to chassis in the event of over-temperature, low oil pressure, etc.

I reasoned that if I connected the start terminal to chassis, the controller should attempt to crank the engine. However, if the generator was already running, it determined this by sensing 120V (one of two windings that are connected in series for 240V). This was monitored via the optocoupler and the frequency-to-voltage converter (LM2917). Anyway, I connected the terminal to chassis and the relay engaged.

The red LED was on and I had power distributed around the board. There was also a green LED and I reasoned that this showed that the system was on, as it indicated the status of the second relay. Applying 120V to terminals 5 and 6 turned off the starter motor and the system appeared to be in a run condition.

Finally, connecting the stop terminal to chassis caused the relay to drop out and returned the unit to the standby condition. Connecting the safety input to chassis would also switch the unit from run to stand-by condition.

So much for the first board. The second unit was similar to the first; R32 was cooked and the green LED was blown, otherwise everything else checked out OK.

All the failures were on the 12V connections to the module and suggested that significantly more than 12V had been applied. Whether these were transients (who knows what else was connected to the 12V system on the boat) or the module had been connected incorrectly, it is impossible to say. The 120V input is part of the same set of terminals but at the opposite end. It would need a fair amount of energy to blow the top off a LED and the resistor failure would most likely have been caused by excessive current, as the protection zener (CR10, 39V) was conducting.

So I suspect it was probably incorrect connections that caused the two modules to fail. Anyway both units are now up and running and my suggestions were passed on.

I don't begrudge anyone earning a fair living and the need to recoup R & D expenses but $800 for such a simple device is really over the top. **SC**

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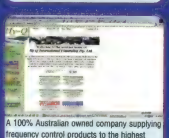

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Using Linux to Share an Optus Cable Modem Internet Connection

Pt.2: installing DNS & DHCP servers

Once you have your cable modem working with Linux, the next step is to set up DNS and DHCP servers. Both can be automatically started during the Linux boot-up and they will make life much easier when it comes to setting up the networking options on your Windows PCs.

By JOHN BAGSTER

It's always a good idea to install both DNS and DHCP servers when using a Linux gateway to the Internet and that applies whether you are using a cable modem or a dial-up connection. Both servers are easy to get going under Linux and they make setting up your Windows boxes a snack.

So what exactly are the functions of these two server utilities and how do they make life easier? We'll start by explaining the role of the Domain Name server (DNS).

DNS servers play a vital role when it come to navigating the Internet. Basically, their job is to translate domain names into their corresponding IP addresses. This means, for example, that you can go to the SILICON CHIP website by typing in **www.siliconchip.com.au** instead of typing the IP address into your web browser: ie, 203.43.52.165.

Typically, you make use of the DNS servers (also known simply as "name" servers) provided by your ISP. This means that, during setup, you have to enter the IP addresses for these servers at the DNS Configuration tab in the TCP/IP Properties dialog box on each of your Windows machines – see Fig.5 last month. Note that there will usually be at least two name servers – a primary DNS server and a backup DNS server.

One potential problem with this is that the two nameserver lines in ***/etc/resolv.conf*** (on the Linux box) may change – eg, if your ISP changes the IP address of one or more of their name servers. This means that you would then have to manually change them on all your Windows PCs or in the DHCP configuration setup that follows. The standard lease time for the Optus modem is 12 hours, meaning that the information in ***/etc/resolv.conf*** could change every 12 hours (although this is very unlikely).

Setting up named

The way around this is to install a name server (or DNS) on your Linux box. That done, you then simply tell your Windows PCs or the DHCP configuration that the name server address is 192.168.0.2 (or whatever IP address you assigned to the Linux PC). Besides, why type in two nameserver IP addresses when you can get away with one?

The name server is a utility called "***named***". If it is installed, it will be in ***/usr/sbin*** but it probably won't be invoked on start-up by default. There will also be a start-up script called named in ***/etc/rc.d/init.d***.

To see if ***named*** is installed, type:

```
ls /usr/sbin/named
```

You should get a response like that shown in Fig.6. Now type:

```
ls /etc/rc.d/init.d/named
```

Both these files should be there. If not you will have to install the bind RPM file.

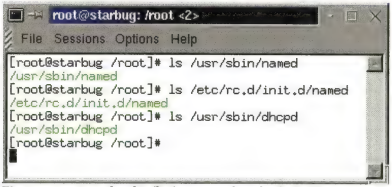


Fig.6: you can use the "ls" (list) command to check that both *named* and *dhcpd* have been installed. You should get responses similar to those shown here in green.

To see if ***named*** is invoked on start-up, type:

chkconfig --list named

You should see something like this:

named 0:off 1:off 2:off 3:on 4:off 5:off 6:off

If you see 3:off instead of 3:on, then type:

chkconfig --level 3 named on

If you are booting to run level 5 – ie, to the GUI (which, by the way, you don't really need for a gateway and firewall), then use 35 instead of 3 in the above line; ie:

chkconfig --level 35 named on

Once that's done, running **chkconfig --list named** should give:

named 0:off 1:off 2:off 3:on 4:off 5:on 6:off

All you have to do now is type:

/etc/rc.d/init.d/named start

That's it – your name server is up and running. What's more, named will automatically start each time the Linux box is rebooted.

DHCP

If you don't want to go to the trouble of manually setting up the networking parameters (fixed IP addresses, gateways, DNS addresses, etc) on your Windows PCs, then you will also want to set up "***dhcpd***". This is the Linux DHCP server and it simplifies network setup and administration in several ways.

First, you don't have to type any information into the Network Neighbourhood properties on each of your Windows PCs. Instead, you can simply set each PC to "Obtain an IP address automatically" (see Fig.10) and ***dhcpd*** will then automatically supply all the necessary information. This includes doling out a unique IP address, plus the gateway and DNS server addresses and the domain name.

Basically, the Linux DHCP server automatically assigns each Windows PC a unique IP address at boot time, along with all the other necessary information. This not only simplifies network setup but also means that you don't have to keep track of IP addresses – something that can become messy if you have more than a few PCs on your network. It also means that you don't need to maintain an ***lmhosts*** file on each PC.

What's more, if the information does change, you can simply run "***winipcfg***" from the Start, Run dialog box on each Windows PC to release and renew the lease. This refreshes all the necessary information and also means that you don't have to manually alter and reboot each Windows PC on the network.

If you are currently using Internet Connection Sharing (ICS), then its likely that your client machines (ie, those not connected to the cable modem) are already set to "Obtain an IP address automatically". That's because ICS includes a basic DHCP server.

In that case, you don't need to alter any of your Windows client machines when you switch over to the Linux gateway – provided, of course, that the Linux box is running ***dhcpd***.

Getting dhcpd going

Like ***named***, ***dhcpd*** is installed in ***/usr/sbin*** and has a start-up file in ***/etc/rc.d/init.d***. Once again, it's probably not configured to start automatically. To check its status, type:

chkconfig --list dhcpd

You should see this:

dhcpd 0:off 1:off 2:off 3:on 4:off 5:off 6:off

If you see 3:off, then type

chkconfig --level 3 dhcpd on

Alternatively, if you are booting to run level 5 (ie, to the GUI), substitute "35" for the "3" in the above line.

One more thing you must do, is modify the ***/etc/rc.d/init.d/dhcpd*** start-up file to make sure it only uses eth0 (or eth1 if that connects to your internal network). By default, ***dhcpd*** attempts to use all network cards and so will refuse to start because there is no configuration for the eth1 network.

Note also that you specifically don't want ***dhcpd*** to use eth1 – your ISP would not be amused if you started supplying IP addresses in competition with them!

Edit the ***/etc/rc.d/init.d/dhcpd*** file and look for a line that contains "**daemon /usr/sbin/dhcpd**" – it's just after

the "start() {" line. Append <space>eth0 to it so that it looks like this (see also Fig.7):

daemon /usr/sbin/dhcpd eth0

That will force ***dhcpd*** to use eth0 only. Don't forget to change eth0 to eth1 if eth1 connects to your internal network and eth0 goes to the cable modem.

Creating dhcpd.conf

You now need to create a ***/etc/dhcpd.conf*** file, which will not exist. You can either type this in yourself or download it from the SILICON CHIP website and modify it to suit.

If you do type it in, be careful as the curly brackets and semi-colons are important. The spacing can either be multiple spaces or tabs to make it neat. The file should look like this:

```
subnet 192.168.0.0 netmask 255.255.255.0 {
        range 192.168.0.1;
        range 192.168.0.3 192.168.0.99;
option subnet-mask 255.255.255.0;
option broadcast-address 192.168.0.255;
option routers 192.168.0.2;
option domain-name-servers 192.168.0.2;
option domain-name "qld.optushome.com.au";
option netbios-node-type 8;
# ddns-update-style ad-hoc;

# 86400 is one day, 2592000 is 30 days
max-lease-time 86400;
default-lease-time 86400;
}
```

The subnet statement tells ***dhcpd*** what network to set up. Usually, your network mask will be 255.255.255.0, in which case the fourth number in the subnet will always be 0. The line here is correct for a 192.168.0.x network. If yours is 192.168.1.x, for example, then change the 192.168.0.0 to 192.168.1.0 and the option broadcast-address line to 192.168.1.255.

If you have several subnets on your PC, you must have a subnet statement for each one or ***dhcpd*** will not start. You can have absolutely nothing between the { }'s if you don't want IP addresses doled out but the subnets must exist. This is a problem with network cards configured with ***dhcpcd***. In this case, you must specify what interfaces you want ***dhcpd*** to use on its command line (it defaults to all).

The range lines tell ***dhcpd*** what IP addresses it can assign to your Windows PCs. In the configuration here, it can assign 192.168.0.1 and IP addresses ranging from 192.168.0.3 to 192.168.0.99. Note that 192.169.0.2 has been excluded here, as this is the fixed IP assigned to the Linux gateway.

Of course, you can change the address range to suit your own needs and you can have as many range statements as you require.

The **ddns-update-style ad-hoc** line is only necessary for the very latest versions of dhcpd. It's commented out here. Remove the comment (ie, the "#" symbol) if it's required.

Option lines

The option lines determine other networking parameters that are to be assigned to your Windows PCs. Note that most of this information would otherwise have to be manually entered into every PC on the network if you weren't using dhcpd.

Let's take a closer look at some of the various option lines and, where applicable, their corresponding entries in Network Neighbourhood:

(1) **option routers** is the gateway address.

(2) **option domain-name-servers** is the DNS IP address. Note that if you are not using named, then you will need to enter both IP addresses in the ***/etc/resolv.conf*** file here (separated by commas); eg,

option domain-name-servers 203.2.75.132, 198.142.0.51 ;

(3) **option domain-name** is the information that you would otherwise have to manually assign to the Domain field at the DNS tab in TCP/IP Properties. It's the same as the domain line in ***/etc/resolv.conf*** and is usually your ISP's domain name unless, of course, you have a private domain name.

This is the one thing you will have to change in ***/etc/dhcpd.conf*** if it ever changes but it is highly unlikely that it will change.

(4) **option netbios-node-type** is for Windows Netbios and is simply left at 8.

(5) **max-lease-time** and **default-lease-time** are usually left at the values shown. The numbers are both in seconds and set the time that the Windows boxes will wait before requesting updated information from the DHCP server. Note: Windows, unlike Linux, will not update the information on restart – it only updates when the lease period expires.

I made mine one day (86400 seconds)

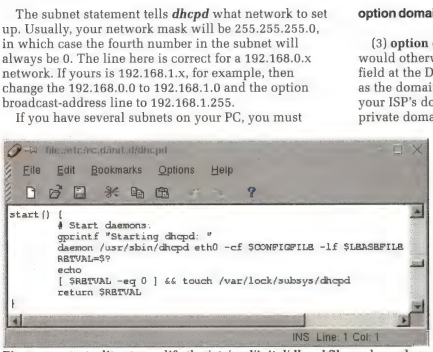


Fig.7: use a text editor to modify the *etc/rc.d/init.d/dhcpd* file as shown here – ie, append *"eth0"* after *"daemon /usr/sbin/dhcpd" (no quote marks).*

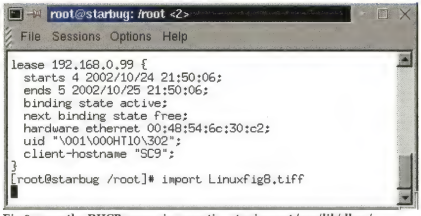


Fig.8: once the DHCP server is operating, typing *cat /var/lib/dhcp/dhcpd.leases* lets you see which IP addresses have been assigned to the various Windows PCs on the network. The lease periods are also shown.

in case the Optus information ever does change but you could make it longer. It doesn't really matter how long or short you make it.

Once you have created your */etc/dhcpd.conf* file there is one last thing you need to do. You must create a file called */var/lib/dhcp/dhcpd.leases*. This initially doesn't contain anything but it must exist or ***dhcpd*** will not start! The command

touch /var/lib/dhcp/dhcpd.leases

is the easiest way to create it. Note, however, that some Linux distributions require this file to be in a different location (eg, in the */var/state/dhcp* folder). If you get an error message concerning this file when you attempt to start DHCP, simply create the file in the location indicated.

That done, you need to start the DHCP server by typing:

/usr/sbin/dhcpd eth0

Alternatively, simply rebooting the Linux box will automatically start the DHCP server (and named) but, hey, this is Linux – you generally don't need to reboot to get things going.

Once ***dhcpd*** has started and assigned IP addresses to the Windows boxes, you can examine the contents of the *dhcpd.leases* file (ie, type **cat /var/lib/dhcp/dhcpd.leases**). This lets you see which IP addresses, etc have been assigned to the various PCs (Fig.8). Note that you may also see the same PC in the file more than once. This is normal, as ***dhcpd*** keeps appending to it and every so often clears it out. The one thing you NEVER do is modify this file!

Setting up the Windows PCs

At this stage, you will have a Linux PC that functions as an Internet gateway (via a cable modem), as a DHCP server and as a name server. This means that it can be used to replace an existing Windows PC with Internet Connection Sharing (if you have one set up). This Windows machine is then reconfigured in the same manner as the other Windows PCs (ie, the "clients") on the network.

Don't forget to uninstall ICS from the retired Windows gateway box, otherwise you will end up with competing DHCP servers. You can also remove the network card that was connected to the cable modem from this box (leaving just the local area network card), although that's not really necessary.

However, it's probably best to remove the surplus card to avoid confusion. The procedure is to first remove the card's driver from Device Manager before powering the machine down and removing the card itself from the motherboard.

If you only had one Windows machine (ie, just one machine connected to the cable modem), then it will already be set up to obtain its IP address (and other information) automatically. Alternatively, if you were running ICS, then the machine connected to the cable modem will have a fixed local network address. This must be altered so that the machine obtains its IP address automatically.

To to that, just follow this procedure:
(1) right-click the Network Neighbourhood icon on the PC's desktop, then left-click Properties in the drop-down list to bring up the Network properties dialog box.
(2) Select the TCP/IP entry for the network card and click the Properties button to bring up the TCP/IP Properties box – see Fig.10.
(3) In the IP Address tab, select "Obtain an IP address automatically".

That's it – provided you have both ***dhcpd*** and ***named*** running on the Linux box, that's all you have to do here. Note that there should be no entries under the Gateway and DNS Configuration tabs. Clear any entries if they are there and select "Disable DNS" under the DNS Configuration tab.

Alternatively, if you don't have ***named*** installed, then you will have to select "Enable DNS" and manually enter the IP addresses of your ISP's DNS servers under the DNS Configuration tab.

Check that your other Windows PCs are set up the same way.

Renewing leases

It will also be necessary to renew the IP address leases on any of the Windows boxes that were previously set up to obtain an IP address automatically (eg, in an Internet Connection Sharing set-up). To do this, first make sure that all machines (including the Linux gateway) are connected to the network. That done, go to each Windows machine, click Start, Run, type in ***winipcfg*** and click OK to bring up the dialog box shown in Fig.9.

Now select the network card, then click the Release button followed by the Renew button (the system might hang if you don't click release first). That's all you have to do – click OK and you won't even have to reboot!

Corrections To Previous Stuff

In the panel on page 43 last month, the gateway address (ie, for the Linux box) is incorrectly listed in several places as 192.168.0.1. This gateway address should be 192.168.0.2.

This means that Fig.3 should show an IP address of 192.168.0.3 and subsequent PCs on the network should be assigned IP addresses of 192.168.0.4, 192.168.0.5, etc (assuming that fixed IP addresses are to be assigned).

Similarly, Fig.4 should show the installed gateway address as 192.168.0.2.

Finally, the IP addresses shown for the "DNS Server Search Order" in Fig.5 should be the same as listed in ***/etc/resolv.conf*** on the Linux box. For the example given, the correct entries would be 203.2.75.132 and 198.142.0.51 (not 192.168.54 and 192.168.54.37).

Of course, you don't have to worry about any of this if you set up both ***named*** and ***dhcpd*** on the Linux box as described in this article. That's because all the necessary networking information is dynamically assigned to the Windows PCs.

Manual network setup

If you don't have ***dhcpd*** installed on the Linux gateway, then you will have to configure the TCP/IP set-up on each of the Windows PCs yourself. Here's the step-by-step procedure:

(1) Take a quick look at the ***/etc/resolv.conf*** file on the Linux gateway with the cable modem connected to it (and obviously with the modem connected to the Internet) and note down the contents of this file. Disconnect the cable modem from the Internet as soon as you have this information (you don't have a firewall yet).

(2) Go to the TCP/IP Properties dialog box on each Windows PC in turn, click the "Specify an IP address button" and enter a unique IP address (eg, 192.168.0.3, 192.168.0.4, etc) and a Subnet Mask of 255.255.255.0 – see Fig.11. Don't use 192.160.0.2 – that's already been assigned to the Linux gateway.

(3) Click the Gateway tab and enter the IP address of the Linux gateway PC (192.168.0.2), then click the Add button.

(4) Click the DNS tab, click Enable DNS and enter the name of the individual Windows PC as the Host name (you can get this name by clicking the Identification tab in the Network properties dialog box). Similarly, enter the domain name in the Domain field (this is the name that appears after the word "domain" in the ***/etc/resolv.conf*** file on the Linux box).

If you installed ***named*** on the Linux gateway, just enter the IP address of the Linux gateway (192.168.0.2) in the DNS Server Search Order field and click the Add button. Alternatively, if you did not install ***named***, then you must enter the IP addresses listed after the nameserver lines in ***/etc/resolv.conf*** (note: these are the IP addresses of your ISPs domain name servers).

Don't forget to click the Add button after each one is entered.

That's it – your Windows boxes are all set up! Click the OK buttons to close the TCP/IP Properties and Network dialog boxes, then reboot the machines when prompted to do so. Now, your Windows PCs should be able to browse the Internet and send and receive email but don't stay connected for more than a minute or so if you don't have a firewall.

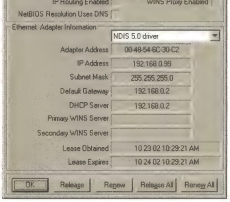


Fig.9: running *winipcfg* tells you the IP address that has been doled out to that machine by the DHCP server. This utility can also be used to release and renew IP leases.

Troubleshooting

The most likely problem you will encounter is that your Windows PCs have trouble obtaining an IP address or there are IP address conflicts. This can easily occur if any or all of your Windows PCs have fixed IP addresses and you have installed ***dhcpd*** on the Linux gateway.

In that case, you must take either of two steps:

(1) Either change the Windows PCs so that they obtain their IP addresses automatically (the easiest solution); or

(2) Ensure that the range of IP addresses in the ***/etc/dhcpd.conf*** file on the Linux box excludes the fixed addresses assigned to the Windows PCs.

If you have a second Linux PC on the network, then presumably it will have a fixed IP address. In this case, copy the ***/etc/resolv.conf*** from the Linux gateway PC to overwrite the one on this second Linux PC. Provided you've installed ***named*** on the Linux gateway PC, you can now replace the nameserver lines in ***/etc/resolv.conf*** on the second Linux PC with one nameserver line that contains the IP address of the Linux gateway.

The other thing you must do on the second Linux PC is edit the ***/etc/sysconfig/network*** file and either change the existing GATEWAY line or add one to point to the Linux gateway PC as follows:

GATEWAY=192.168.0.2

Note that you do not need to enable IP forwarding in ***/etc/sysctl.conf*** on this second machine.

After these changes, you will have to restart the

How To Set Up Your Windows PCs . . .

(1) Named & DHCP Both Running

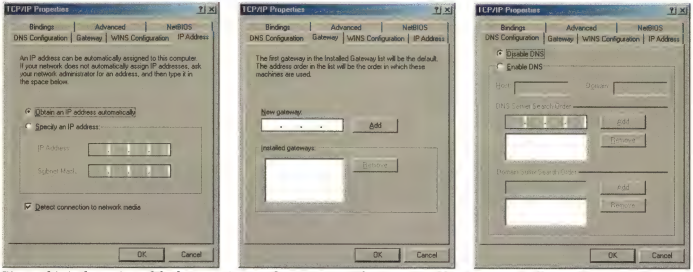


Fig.10: this is the easiest of the lot – you just set the system to "Obtain an IP address automatically" and leave the Gateway and DNS Configuration entries blank.

(2) Named Running But No DHCP

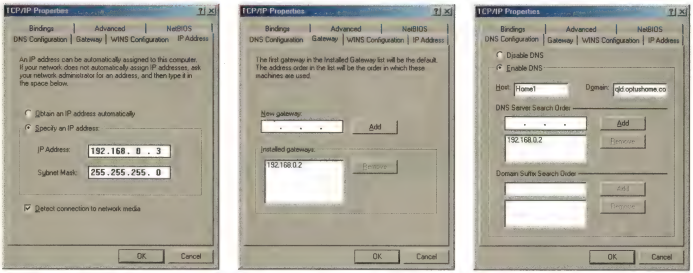


Fig.11: in this case, you have to assign each Windows PC a unique fixed IP address and a subnet mask of 255.255.255.0. In addition, the Linux gateway address (192.168.0.2) must be entered into both the Gateway and DNS Configuration dialog boxes and you have to enter the name of the computer (ie the host name) and the domain name (qld.optushome.com.au). The setup is almost the same if neither named nor DHCP are running. The difference is that you have to enter the IP addresses of the two nameservers (found in /etc/resolv.conf) into the DNS Configuration instead of just the gateway IP.

networking on the second Linux PC (or reboot it). Alternatively, if you have installed ***dhcpd*** on the Linux gateway PC, you could configure the network card in the second Linux box to use ***dhcpcd*** (instead of assigning it a fixed IP address). If you do this, you don't need to bother changing ***/etc/sysconfig/network*** or ***/etc/resolv.conf*** at all.

Basically, the network card in the second Linux box is configured the same way as the modem network card in the Linux gateway PC. In this case, however, the DEVICE line should point to eth0 and the PCs own name should be used for the DHCP_HOSTNAME.

However, before you rush in, you need to set up a firewall on the Linux gateway PC. If you don't, someone "out there" could take over your fancy new network. We'll take a look at firewalls in Pt.3 next month. **SC**

GW Instek is a brand produced by the Goodwill Instrument Company of Taiwan. The model GRS-6032 is an interesting scope which combines the attributes of a 30MHz dual trace analog CRT readout scope with digital storage.

GW Instek GRS-6032 30MHz Real Time Digital Storage Oscilloscope

WHILE DIGITAL SCOPES have made great advances over the last 10 years or so, there is still a place for capable analog scopes at reasonable prices. In this GW Instek model, we have a scope with a foot in both camps but with many of the operating attributes of an analog scope.

At first sight, the GRS-6032 looks quite conventional, as an analog scope. It uses a conventional cathode ray tube and so it has quite a deep case. Front panel measurements are 270 x 129mm while the overall depth is 410mm, including the rear feet which double as power cord storage. The CRT screen is 102 x 85mm and it has a conventional graticule 10 divisions wide and eight divisions high. Weight of the unit is 8.5kg.

On the front panel there are 11 knobs, four large and seven small, and there are 28 pushbuttons, some of which have associated illuminated legends. All of these light up in sequence as part of the scope's self-test procedure when you first turn it on.

It is not until you start to use it that you realise that the GRS-6032 is different from analog scopes in the past. It is also a CRT readout scope in which the CRT text takes the place of much of the labelling on the front panel controls.

For example, none of the front panel controls such as the input attenuators and the timebase switch have any calibrations, apart from those applying to their maximum and minimum settings. When you alter these switches, their settings are shown on the CRT screen. In fact, virtually every setting

made via the front panel controls is indicated in some way on the CRT screen.

For example, in a typical setup with both channels in use, the input attenuator settings will be shown in millivolts or volts/division (1mV/div to 20V/div) and the input coupling will be shown as AC (with a squiggle), DC (equal symbol) or grounded (with an earth symbol).

Timebase settings will be shown in seconds, milliseconds, microseconds or nanoseconds/division (the last setting only available in the timebase multiply mode). Timebase settings range from 0.5s/div up to 0.2µs/div and you can add magnification of x5, x10 and x20 to give a maximum timebase speed of 10ns/div.

Trigger source settings are shown as CH1, CH2, line or external while trigger coupling is shown as AC, HFR (high frequency reject) or LFR (low frequency reject). Also shown is trigger slope (positive or negative and TV sync (Horizontal or Vertical).

To add to the fun, some of the buttons have double functions which are brought into play either by momentarily pressing them or holding them down to display the wanted function on the screen. For example, for each vertical input channel there is a button marked "GND" and "Px10". Pushing this button briefly, grounds the relevant channel input (handy to set trace reference levels) and displays the earth symbol next to the vertical attenuator setting at the bottom of the screen. Holding the button down for a longer period selects for a x10 probe and reduces the input sensitivity by a factor of 10; eg, 10mV/div becomes 100mV/div.

Similarly, underneath the CH2 select button is another button labelled "Add" and "INV". Pushing this button briefly enables you to add the two channel signals and display them as one trace. This causes a "+" symbol to be displayed next to the vertical input info for CH1. Holding the button down longer inverts the signal from CH2 and so the waveform displayed is the difference between the two channel signals. In this mode, a downwards arrow is displayed next to the "+" sign on the screen.

As well as the screen prompts, the vertical input attenuators and the timebase knob cause a brief beep to be sounded when you wind the controls beyond their maximum or minimum settings. You can turn the beep off, if you wish. By the way, none of the four large knobs have rotation stops, which is why the beeper comes in handy.

The rear panel has two BNC sockets, one for the CH1 output and the other for Z-axis modulation. The D-sockets is the RS232 interface which can be used with optional software to display and store waveforms on a PC.

Horizontal and vertical cursors can be switched on for period or voltage measurements and the large knob at the top lefthand side of the panel is used for fine or coarse movements of the cursors, either separately or as a pair.

By now then, you should have the strong impression that this is an easy-to-use analog scope, with strong emphasis on the CRT-readout (ie, text on screen).

Digital storage

Digital storage operation is brought into play by the five blue buttons on the control panel. Selecting "storage" switches over to digital mode. The sample rate is now displayed at the top of the screen (up to 20 megasamples/sec) and a vertical trigger cursor is shown as well. Its position can be moved across the screen by the fine/coarse knob.

The menu button has five functions. First, you can turn smoothing on or off. Smoothing on removes some of the "jaggies" on a typical digital scope waveform and also changes from a dot display to one with the dots connected.

Second, you can use Average mode whereby waveforms are averaged to remove the effects of random noise. You can select 2, 4, 8, 16, or up to 256 waveform averages. Naturally it only works with repetitive waveforms (eg, sinewave) and it takes quite a while to produce the higher average setting.

Third, you can select an interpolation mode which can be handy when you are displaying magnified data (brought into play by using timebase magnification). Fourth and fifth, you can save and recall up to nine reference waveforms.

Other buttons used in the digital mode are run/stop, single (trigger) and utility. The last button allows you to load factory default or create your own default panel settings, to turn the beeper on or off and finally to set the RS232 baud rate (300, 1200, 2400, 4800 or 9600) for the serial interface.

Overall, the GRS-6032 has been thoughtfully designed and the clever use of the CRT readout text really does make it quite straightforward to use.

It comes complete with two switchable x1/x20 60MHz probes and a quite well-written and succinct instruction manual.

It is priced at $1499.30 including GST. For further information on this and other GW Instek oscilloscopes, contact the Australian distributors, Emona Instruments Pty Ltd, phone 1800 632 953 or via the web at www.emona.com.au **SC**

SuperCharger

Build this advanced small-cell charger and step up to the newest generation of super-capacity rechargeable batteries – Pt.2

Last month, we looked at the features of our new intelligent SuperCharger, described how the circuit worked and showed you how to assemble the main PC board. This month, we complete the construction and give you the driving details.

Pt.2: By PETER SMITH

ONCE THE MAIN board has been assembled, it's simply a matter of completing the small front-panel board, wiring them together and completing the assembly. But first, there are a couple of minor modifications to the main board. The accompanying panel has the details.

Front panel board assembly

Referring to the overlay diagram (Fig.9), begin by installing the 11 wire links, followed by the resistors. Next, turn the board over and install the two remaining resistors on the bottom (copper) side, as shown in Fig.10. Cut the protruding resistor leads off flush with the surface of the PC board (on the top side).

Moving back to the top side, install the connector (CON7) followed by the 33µF tantalum capacitor. Mount the capacitor horizontally rather than vertically and fit a short length of heatshrink tubing over its negative lead to ensure that it cannot short out on nearby components.

Transistors Q5-Q8 can go in next, followed by the four pushbutton switches. It is particularly important that the base of each switch is seated firmly on the PC board surface during soldering. Be sure to install the red switch in the S4 position and make sure that the flat side of each switch is oriented as shown.

The final step involves mounting all the LEDs and fitting the board to the front panel. Start by installing each LED in place but do not solder or cut the leads short just yet. Note in particular the orientation of the anode and cathode leads for each column of LEDs – they differ between the left-hand and righthand columns, as indicated in Fig.9.

Follow the details in Fig.11 to mount the PC board to the front panel. That done, place the face of the panel on a flat surface and push the LEDs into their designated panel holes. If you

would like the LEDs to protrude through the panel slightly, then raise the panel the desired amount and push the LEDs through until they contract the flat surface below. Solder them into position to complete the job.

Cabling

The front panel is hooked up to the main board via a length of 10-way rainbow cable, fitted with header sockets on both ends. Keep this cable as short as possible but allow about 20mm of slack so that it's not stretched tight when installed. The header sockets must be carefully wired, as it is very easy to mistakenly reverse the wiring order.

Fig.12 shows how it's done. Double-check (with the finished cable connected) that pin 1 of CON4 on the main board connects to pin 1 of CON 7 on the front panel, using the overlay diagrams as a reference.

All four discharge globes are wired in parallel with light-duty hook-up wire. Insulate the connections to the rear of the bezels with heatshrink tubing. Route the cabling as shown in the various photos.

Use medium-duty (5A or higher) figure-8 cable or similar for the battery connections, keeping the length down to around 400mm or so. Bend the cable sharply as it exits the terminal block (CON5) to avoid Q2's heatsink, then route it alongside the 1000µF capacitors and out through the rear panel. That done, place a cable tie around the cable at the point where it enters the grommet (on the inside of the case) so that it can't be pulled through from the outside.

Mark the positive battery lead clearly or, better still, use some kind of keyed connector with your chosen battery holder(s). Accidentally connecting your batteries in reverse could easily ruin all your hard work!

Initial tests

Before installing IC2, IC3 and IC4 on the main PC board and connecting the front panel, it's a good idea to check that the power supply circuitry is working properly. To do this, you'll need a digital multimeter and a spare 15kΩ 0.25W resistor. The resistor is needed to provide a minimum load for IC3's V_{DD} supply.

Referring to Fig.13, insert and solder the resistor to the unused pads situated on either side of the 4.7µF tantalum capacitor. Once that's done, plug the 3A fuse into its clips and connect a 16VAC 1.5A plugpack to CON1. Before applying power, however, take a moment to recheck your work against the overlay diagram. Assuming all is OK, hold your breath and hit the power switch.

No surprises? Great! All measurements that follow are with respect to

Main PC Board Update

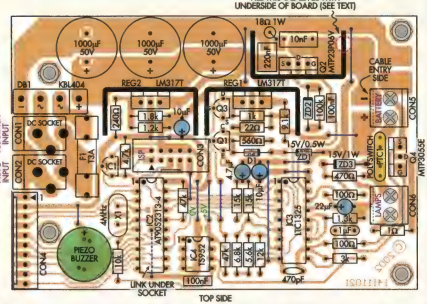


Fig.7: the overlay diagram for the top side of the main PC board, updated and reproduced again this month for convenience.

Since the first part of this project was published, we've had the opportunity to test the SuperCharger with a greater variety of batteries and power sources. Our tests revealed that a few small changes to the original design were required.

Two additional parts are needed for the main PC board, as follows: (1) 1 18Ω 1W 1% or 5% metal film resistor (R38) (Farnell 337-640) (2) 1 10nF 250VAC polypropylene capacitor (7.5mm lead pitch) (C19) (Farnell 303-9146)

We've reproduced a small section of the circuit diagram (Fig.8) to show where these two new components are located. They function as a simple R-C damper (or 'snubber'), reducing high frequency ringing when Q2 switches on and off.

Both components are installed near Q2, with the resistor mounting vertically rather than horizontally. Note also that the capacitor mounts directly above the SMD diode (D3), so it is particularly important to ensure that D3 is positioned so that it does not obscure the capacitor's mounting holes.

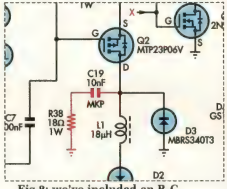
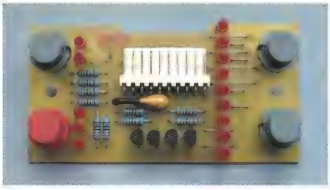
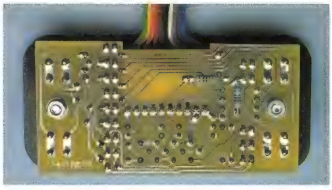


Fig.8: we've included an R-C damper on the final version of the main PC board, shown here in red.

We've also changed the value of inductor L1 from 22µH to 18µH. Finally, we've relocated the 470pF (C14) and 1µF (C10) capacitors slightly.

The PC board pattern shown in Fig.16 contains all of these changes and an updated parts overlay diagram is reproduced above in Fig.7 for convenience. The PC pattern sent to the board manufacturers also includes these changes.





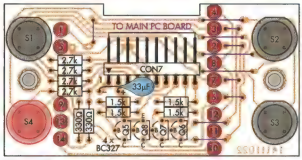


Fig.9: overlay diagram for the front panel PC board. The 33µF capacitor must be mounted horizontally (see above photo), with heatshrink tubing on its leads to prevent short circuits. Note that the lefthand and righthand columns of LEDs are orientated differently.

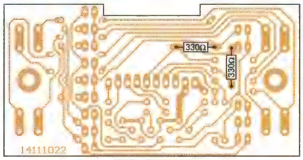


Fig.10: just two resistors are mounted on the copper side of the front-panel PC board. Position the resistor bodies so that they are close to the surface of the PC board, as shown in the above photo, before soldering their leads.

the ground (0V) rail. A handy ground connection point can be found on pin 1 of CON4.

First, check the DC (V_{IN}) rail at the cathode of ZD2. It should measure about +21.5V. If you're using a plugpack other than what we've recommended in the parts list, be aware that this voltage must *not* exceed +24V, otherwise the transient suppression diode (TVS1) will conduct and may be destroyed.

Next, check the +5V rail, accessible on pin 2 of CON4, pin 20 of IC2 and pin 8 of IC4. Finally, check IC3's V_{DD} supply by probing the end of the 15kΩ resistor (installed earlier) closest to Q1. You should get a about +15V.

If all readings check out, then power down and remove the 15kΩ resistor. Install the three ICs, being sure to align pin 1 of all devices as shown on the overlay.

We haven't specified sockets for IC3 and IC4, as we believe they would reduce the reliability of the project. However, if you're wary about soldering these (expensive) little devices, then we recommend using high-quality, turned-pin sockets. If you can't source an 18-pin socket for IC3, then you can cut the two end pins off a 20-pin version with a sharp knife and tidy up with a fine jewellers file.

Programming the micro

If you've purchased this project as a kit, then the microcontroller (IC2) will have been programmed for you. Alternatively, if you've sourced all the parts yourself, then you'll need to program the Flash and EEPROM memory in the micro. We've provided an ISP (In-System Programming) header (CON3) for connection to an 'Atmel-compatible' programmer for the task.

Two suitable programmers have appeared in the pages of SILICON CHIP, the most recent in October 2002. A

WHERE TO GET THE PARTS

At time of publication, the SuperCharger was not available as a kit from the usual suppliers. However, all of the parts are available locally (see parts list), with the exception of two items:

(1) The LTC1325CN (IC3) can be purchased directly from the manufacturer, Linear Technology. You can buy on-line at **www.linear-tech.com**

(2) The 18µH inductor (L1) used in the prototype is manufactured by Sumida Corp., part number CDRH127-180MC. It can be purchased on the web from Digi-Key at **www.digikey.com**.

Inductors from three other manufacturers have also been identified as suitable. These are: (a) Part no. 3631C180ML, manufactured by Meggitt Electronic Components (**www.meggittelectronics.com**); (b) Part no. TSI-1207P-180, manufactured by Selmag Co. (**www.selmag.com.tw**); and (c) Part no. TPRH1207-180M, manufactured by Top Magnetics Corp. (**www.topmagnetics.com**).

As usual, the PC boards and programmed microcontroller (IC2) will be available from RCS Radio, phone (02) 9738 0330.

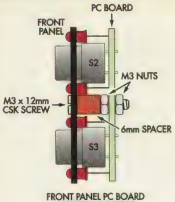


Fig.11: about 8mm of space is required between the front panel and the PC board. This is easily achieved with 6mm spacers and M3 nuts, as shown here.

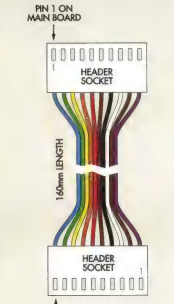


Fig.12: how to wire the 10-way cable that connects the two PC boards together. Ignore the pin 1 mouldings on the sockets and follow this diagram and the directions in the text closely.

simpler design was presented in the October 2001 edition.

The necessary program files for the microcontroller can be downloaded from the SILICON CHIP web site at: **www.siliconchip.com.au**

Battery holders

Almost any style of battery holder can be used with the SuperCharger. However, it is unlikely that the low-cost plastic varieties will perform well when rapid-charging high-capacity cells. The current rating of most cheap holders is probably only a few hundred mA at best, which explains why we've seen them melt under heavy load!

In addition, it's too easy to accidentally reverse a cell in a multi-cell holder. With this in mind, we've designed a PC board that will accept up to six single-cell holders of either the low-cost or high-current variety.

The overlay diagram for the battery holder PC board is shown in Fig.15. The board has mounting positions for four types of holders, including three high-current types in sizes AA, AAA & ½AA (available from Farnell, see parts list) and a low-cost AA size.

The holders are connected in series, so you need only install the number that you require. Populate from the CELL1 end and work up. The high-current holders should be mounted securely with two M3 x 10mm CSK screws, nuts and washers before soldering. These holders include both solder pins and tags for push-on terminals. We cut off the unused tags with sidecutters and cleaned up the sharp edges with a jeweller's file for a neater appearance.

If you've opted for the low-cost AA holders, then you'll need to trim the flying leads to about 10mm in length before stripping and tinning the ends. Secure them with M2 x 6mm screws and nuts. Note that the board will also accept low-cost AAA and ½AA sizes but you'll need to drill additional mounting holes to suit.

The charger connects to the holder via a 2-way terminal block plug and PC-mount terminal block sockets. As shown in Fig.14, we've made provision for one socket per holder (CON101 – CON106)

To determine the number of 2-way terminal block sockets required, first consider the number of cells you will be charging together. For example, it you've installed all six holders and will be charging one, two, four and six cells together, then install the first (CON101), second (CON102), fourth (CON104) and sixth (CON106) sockets only.

We've provided sockets in this 'series' configuration to eliminate the need for switches to select the number of cells to be charged. In use, you simply insert the cells by starting at the bottom (CON101) position and working up. The charger plug is then inserted into the socket adjacent to the last cell. For example, if you have inserted four cells, then plug the charger into the socket next to the fourth cell (CON104).

Fig.13: temporarily solder a 15kΩ resistor in circuit for power supply testing. We've provided a couple of spare pads for the purpose, positioned on either side of the 4.7µF tantalum capacitor.

To protect your furniture as well as the underside of the PC board, fit 10mm (diameter) self-adhesive rubber or acrylic feet to the corners of the completed PC board. Note that the feet need to be positioned close to the corners of the board so that it doesn't tilt over when installing batteries.

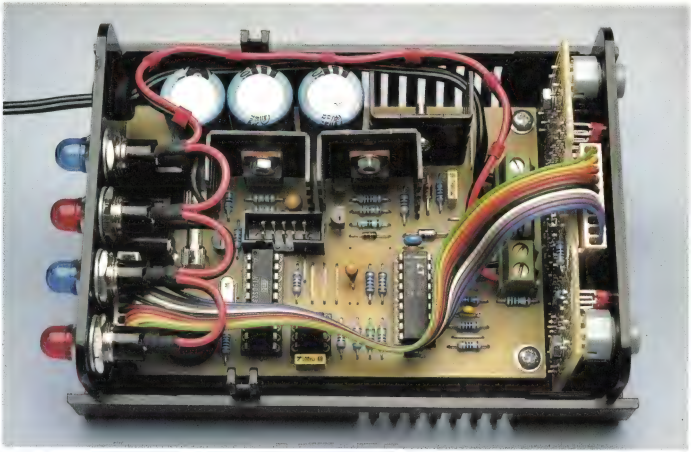
Operation

Driving the SuperCharger is quite straightforward, with all operations selected via the four front-panel pushbutton switches.

The 'Cell Type' button allows selection of either NiCd or NiMH-type batteries. Essentially, this setting selects either a 1C (NiMH) or 1.5C (NiCd) charge rate for the rapid charge mode. It has no effect in fast charge mode, where both types are charged at their 0.5C rates. Don't be tempted to charge NiMH batteries on the NiCd setting – you'll probably damage your batteries!

Note also that the maximum charge rate for both battery types is 1800mAh. This means that NiCd batteries larger than 1200mAh will be charged at slightly less than their 1.5C rate.

The vertical column of nine LEDs has two functions. Initially, they indicate the chosen cell capacity, which can be increased or decreased using



Building the SuperCharger is easy, with virtually all the parts on two PC boards: a main board and a front panel board. Note how the 10-way cable is installed.

the 'up' and 'down' buttons on the right-hand side. Once charging has commenced, they then indicate elapsed time as a percentage of the maximum expected time for a full charge. Unless you're charging completely exhausted batteries, you'll probably find that not all the LEDs in the column light before the charge completes.

Once cell type and capacity are set, it's then just a matter of pressing the 'Go/Stop' button once for rapid charge or twice for fast charge. To perform a discharge before charge, hold down the button until you hear two 'beeps'.

We've also included a standard (0.1C) 16-hour charge mode for recovering cells that will not accept a full charge at the rapid or fast rates. The operational flow chart in Fig.17 details how to access this mode. It also shows how you can determine the state of any charge as it advances through the various modes to completion.

If you need your batteries in the shortest time possible, then you can halt the cycle at the end of the rapid

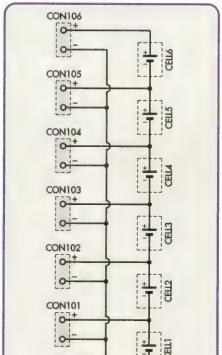


Fig.14: the circuit diagram for the optional battery holder PC board.

charge period, rather than wait for the 2-hour top-up. At this point, somewhere between 90 and 95% of battery capacity will have been returned (assuming the cells are in good condition!). It is important, however, that you occasionally allow the top-up charge to complete so that all cells in a set can be equalised.

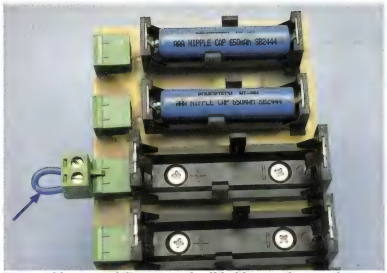
Hitting the 'Go/Stop' button at any point in a charge cycle will return to the standby state. This is also the recommended way of terminating a trickle charge before removing your fully charged cells!

Cycling problem batteries

The new-generation batteries do not suffer 'memory effect' but they can exhibit a similar problem called 'voltage depression'. The most obvious symptom of this problem is low charge acceptance. Even fully discharged cells with this problem will not accept a full charge at the fast (0.5C) or rapid (1C or 1.5C) rates.

In our experience, this problem is common amongst newly-purchased cells, probably because they have been stored for long periods before sale.

To eliminate, or at least greatly reduce the effects of voltage depression,



It's possible to mix different-sized cell holders on the same battery-holder PC board. Here we have used both AA (bottom) and AAA sizes. The shorting link (arrowed) is necessary to allow the top two holders to be used in isolation but must be removed when using any of the bottom (AA) holders.

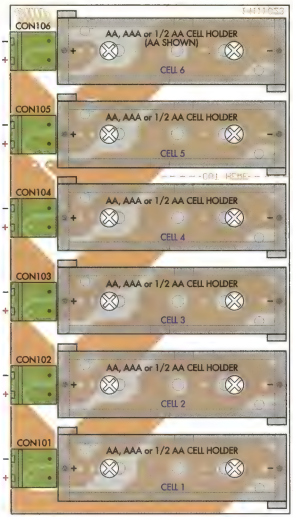


Fig.15 (right): the battery holder PC board overlay, shown here with high-current AA-size holders installed. Note that if you only ever intend charging a maximum of four cells, then you can cut off the top section of the PC board along the 'cut here' line.

we've found that a full charge at the standard (0.1C) rate followed by a number of discharge and charge cycles at the fast/rapid rate is effective.

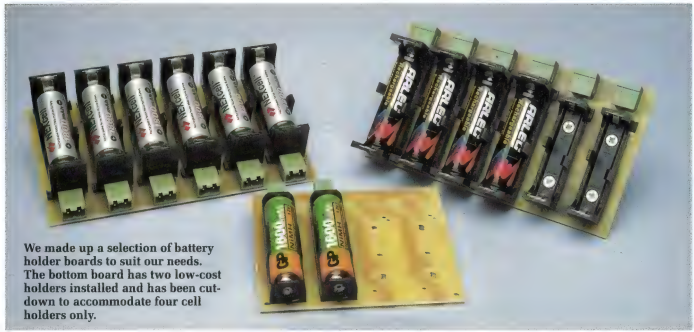
In use, it can take many fast/rapid charge cycles before a set of cells will deliver close to 100% of their rated capacity.

Discharge-before-charge

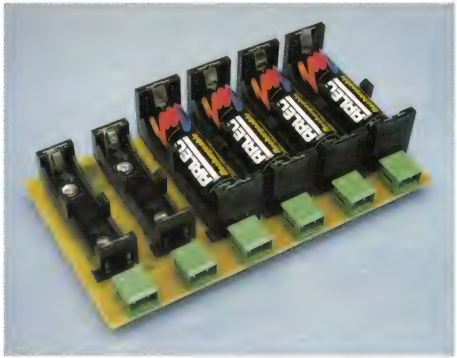
The SuperCharger provides a discharge-before-charge function, albeit with several limitations. These are as follows:

(1) Do not select discharge-before-charge if your batteries are already 'flat'. The terminal voltage for each cell must be within the nominal range (around 1.2V) in order for the SuperCharger to correctly determine the number of cells connected.

(2) Between two and six cells must be connected for the discharge function to work properly; it does not work



We made up a selection of battery holder boards to suit our needs. The bottom board has two low-cost holders installed and has been cut-down to accommodate four cell holders only.



Another view of the mixed cell holder board with four AA cells in position. Note that the shorting link has been removed.

TABLE 1: BEEP ERROR CODES

Beeps	Error	Description
1	No error	Indicates beginning & end of charge cycle.
2	No error	Indicates discharge-before-charge selected.
3	Reverse cell check	Check for reversed cells. If OK, hit 'Go/Stop' again.
4	EEPROM checksum error	EEPROM is corrupted and needs reprogramming.
5	Can't autorange	Unable to detect number of cells connected.
6	Charge timeout	Battery voltage is less than 850mV after 3 hours (shorted battery).
7	Low voltage battery	Battery voltage decreased below 850mV during charge (possible shorted battery).
8	High voltage battery	Battery voltage too high (high resistance/open circuit cell or battery disconnected).
9	Input voltage too high	Input voltage exceeds 24V. Disconnect immediately!
10	Input voltage too low	Input voltage is less than 12V.
11	No headroom	Input voltage is too low to charge current battery.

When an error is detected, all LEDs on the front panel flash and the piezo buzzer 'beeps' an error code. This table lists all the codes and their interpretations.

TABLE 2: WHERE TO GET BATTERY INFORMATION

Manufacturer	Website
GP	http://www.gpbatteries.com.hk
Eveready	http://data.energizer.com
Panasonic	http://www.panasonic.com/industrial/battery
Sanyo	http://www.sanyo.com/industrial/batteries
Powerex	http://www.mahaenergy.com/products/prosumer/batteries.htm
Kodak	http://www.kodak.com/global/en/consumer/products/batteries
Rayovac	http://www.rayovac.com/products/recharge/recharge.shtml

with just one cell. In addition, it should not be used with 9V (or 7.2V) PP3 size batteries.

The batteries are discharged into a simple resistive load, consisting of four parallel-connected 12V 120mA globes. Therefore, the discharge current will vary according to the number of cells installed. For example, with only two cells installed, the discharge current will be about 120mA, whereas with four cells installed it will be about 240mA. This means that you'll need to allow a considerable amount of time when cycling high-capacity cells.

To speed up the discharge, you can customise the load to suit your requirements. For example, if you only intend discharging a maximum of four cells, then you can replace the 12V globes with 6V versions, thereby roughly halving the discharge time.

In-car use

A separate DC input has been provided for connection to any low-impedance 13.8V 1.8A DC source, such as a car cigarette lighter socket.

Up to five cells can be charged in series from a 12V car battery. However, a minimum of 13.2V is required to fully charge a typical 6-cell stack (eg, a 7.2V R/C battery pack), so you'll need to have the engine running. If the voltage dips below the required minimum, the charge will terminate with an error (see Table 1).

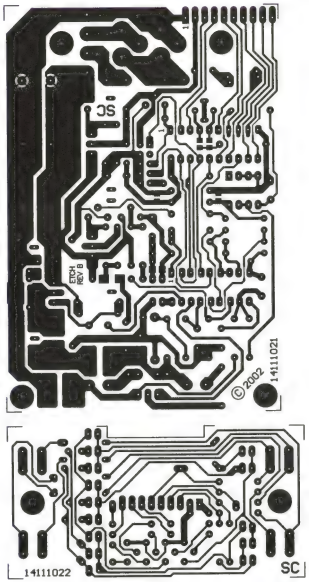
We strongly recommend that the charger be disconnected from the vehicle's electrical system during engine start to prevent possible damage to the sensitive electronic circuitry.

The Chargemeister's tips

We've already talked about some of the more important elements of recharging. Here they are again, grouped together with a couple of new points that you should find useful.

(1) Keep all contacts clean. This applies to both the battery terminals and holder contacts. Corrosion on or around contacts should be cleaned up immediately. If a contact's plating is damaged (eg, if it is pitted or peeling), it should be replaced.

(2) Always keep batteries together as a set (as used in the end equipment). This ensures that all cells within a set are roughly equivalent in 'strength', thus maximising the life of all. One way of achieving this is to mark each cell with an identifying 'set



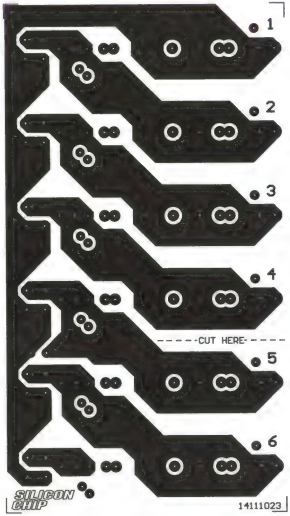


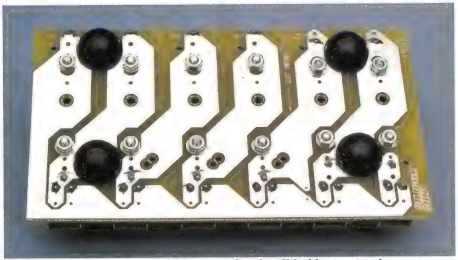
Fig.16: full-size patterns for the main, front panel and optional battery holder PC boards.

number'. In other words, "'till death do us part!"

(3) A maximum of 6 cells can be charged in series. Unless approved by the battery manufacturer, don't charge cells in parallel.

(4) Ambient temperature has a big effect on cell charge/discharge efficiency and reliability. Where possible, charge your batteries at room temperature (about 21°C). Avoid rapid or fast-charging batteries at less than 10°C or greater than 40°C.

(5) Avoid totally discharging your batteries. Manufacturers build over-discharge protection into all rechargeables these days but repeated total discharge will shorten life considerably. Generally, when you notice a sudden drop in output (light, sound,



We fitted four rubber feet to the bottom of each cell holder to stop them scratching desk tops. Note that these are not close enough to the corners to stop the holder from tilting over when cells are installed.

etc), remove the batteries and recharge as soon as possible.

Rechargeable batteries are ideal for use in many high-drain projects. Cells with solder tags, rather than nipples, are often the best choice, so why not make up your own battery packs? Soldering the cells together eliminates potential connection problems and ensures that they're always part of the same set.

Note that the focus of this project has been on recharging small, cylindrical cells in the AA and AAA size ranges. However, the SuperCharger can also handle other NiCd and NiMH batteries with ratings between 200mAh and 1800mAh. Always check the manufacturers specs (often available on the web) for maximum charge rates.

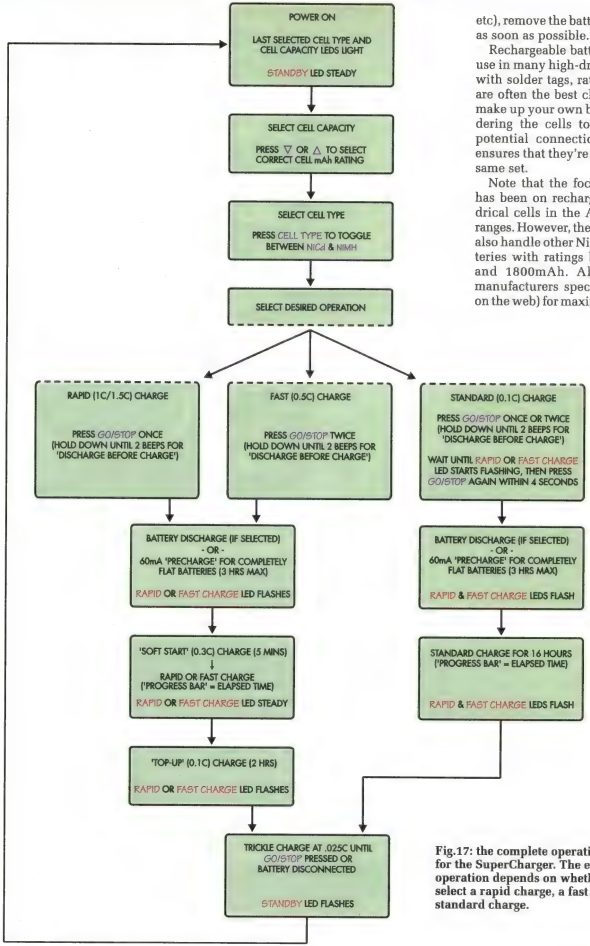


Fig.17: the complete operational chart for the SuperCharger. The exact mode of operation depends on whether you select a rapid charge, a fast charge or a standard charge.

This is especially important for NiMH batteries!

Recovering flat/shorted cells

Cells that have been over-discharged or reverse-charged can usually be recovered by the SuperCharger's 'precharge' function. This function is automatically invoked before the main charge begins if the total battery voltage is less than 900mV.

Using a constant current of about 60mA, the SuperCharger will try (for 3 hours max.) to bring the battery voltage up above 850mV. If successful, the charge progresses to the next stage, otherwise the battery is assumed short-circuit and the charge terminates with an error (see Table 1).

Note that if the initial battery voltage is less than 200mV, then the SuperCharger will flash all LEDs and 'beep' three times, prompting you to check that you have not accidentally connected any cells in reverse. If all is OK, simply hit the 'Go/Stop' button again to continue with the charge.

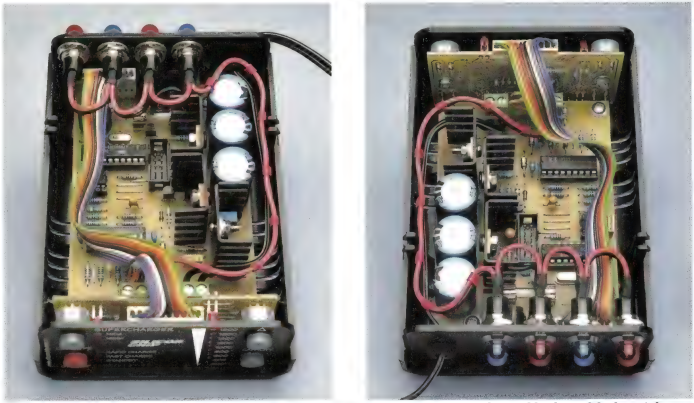
It's quite common for cells to go short-circuit near the end of their lives. We've even seen this happen to comparatively new cells that have been lying idle for a couple of years. So what can you do about it?

Some say that if a cell is shorted, it's at the end of its life anyway, so it may as well be discarded. That's possibly true but if you'd like to have a shot at resuscitation, take a look at the 'Nicad Zapper' project in the August 1994 edition of SILICON CHIP. This works by applying a brief, high-current pulse to the cell, 'blowing out' the dendrite growth that is usually responsible for short-circuiting the plates.

The rear panel of the SuperCharger carries the four discharge globes and the power sockets.

A suggested modification to the Nicad Zapper project appeared in Circuit Notebook, June 1995. It simplifies the original design by eliminating the power supply circuitry.

Note that when recovering shorted or reverse-charged cells, charge each cell individually (rather than in series with other cells) at the standard (0.1C) rate for the first cycle. **SC**



Use these photographs to guide you when installing the internal wiring. Keep the rainbow cable clear of the heatsinks.

VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

Intermediate Frequency (IF) Amplifiers; Pt.1

The IF stage is an important circuit section in all superheterodyne radio receivers. Here's a look at how the IF stage evolved in early broadcast-band AM radio receivers and the problems that were overcome along the way.

In a superheterodyne receiver, the IF amplifier has a number of tasks to accomplish. First, it sets the selectivity of a receiver (ie, the ability to separate stations), whether tuned to 30MHz (megahertz) or 550kHz (kilohertz).

If you've ever tuned an Astor "Football", a tuned radio frequency (TRF) set, you will notice that the selectivity is good at 550kHz but is quite broad at 1600kHz. At 1600kHz, stations up to 30kHz away from the designated tuned frequency can be heard in addition to the desired station. However, this is not usually a serious problem, as stations are allocated channels at least 100kHz apart in any particular area.

The IF amplifier stage also provides most of the radio frequency (RF) amplification in a superheterodyne receiver. This means that fewer stages are required to obtain the same performance compared to a TRF set. It is also much easier to set up, with just a few screwdriver adjustments required for alignment, and is often the only stage in a receiver that has automatic gain control (AGC/AVC) voltages applied to it.

Finally, some IF amplifier valves include detector and AGC diodes. So the IF amplifier stage is a very important part of a superhet radio receiver.

The frequencies used

Over the years, manufacturers have used many different intermediate frequencies (IFs) in their receivers. For example, in very early Australian domestic sets, the IFs were in the order of 30, 45, 50 and 60kHz. However, once superheterodyne receivers be-

This photo show a selection of several large-size IF transformers.

This large IF transformer includes a top-cap grid connection lead.

came properly established, the common IFs used were as follows: 173kHz, 175kHz, 181.5kHz, 182.5kHz, 200kHz, 210kHz, 212.5kHz, 220kHz, 226kHz, 250kHz, 252kHz, 252.5kHz, 262.5kHz, 390kHz, 445kHz, 446kHz, 450kHz, 452kHz, 453kHz, 453.5kHz, 455kHz, 456kHz, 457.5kHz, 458kHz, 460kHz, 462.5kHz, 465kHz, 469kHz, 472.5kHz, 475kHz, 550kHz and 595kHz.

That's quite a list and covers 36 different frequencies that were used by various manufacturers in Australia over the period that domestic superheterodyne radio receivers have been around. Both 550kHz and 595kHz appear to have been used by some sets when tuned to shortwave, or in shortwave converters. On the other hand, high-fidelity AM tuners often used 1900kHz and some earlier communications receivers used 1600kHz or 1650kHz.

Later high-frequency (HF) communications and other specialised receivers used a number of other frequencies, including frequencies around 45MHz and 70MHz in the VHF range. However, we are not interested in those in this article.

The next question to ask is which IF frequency is the "best"? The answer is that there is no "best". They all have their good and bad points. Initially, superhets used very low IF frequencies, as mentioned above. These low IFs (30-60kHz) enabled triode valves to be used with no neutralisation and provided quite high selectivity. However, their big disadvantage was that they suffered intolerable "double-spotting".

Double-spotting

"Double-spotting" is a term that means that the wanted station is tuned in at two spots on the dial. These spots would be just 60kHz apart if an IF of 30kHz is used. So how does this occur?

In a superhet receiver, the local oscillator frequency is offset from the wanted station by the frequency of the IF amplifier. For example, let's say that the wanted station is on 800kHz and the IF is 30kHz. This means that the local oscillator (which is usually higher in frequency than the tuned station) will be on 800 + 30 = 830kHz.

However, if the selectivity of the RF stage is quite poor, a station on 860kHz will also give a 30kHz IF output when mixed with the local oscillator (on 830kHz). As a result, two stations – one on 800kHz and one on 860kHz – will be received at the same time.

If the receiver is now tuned to 740kHz the oscillator will be on 770kHz. However, this will also give a 30kHz IF output from the 800kHz station. This means that the 800kHz sta-

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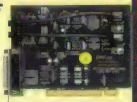
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These 455kHz (top) and 1600kHz IF transformers have been dismantled to show the windings. The windings are secured inside the metal cans for protection and shielding.

tion is heard at both the 800kHz and 740kHz positions on the dial.

Indeed, it was virtually impossible to stop double-spotting on these early sets with very low IFs, as the selectivity of the aerial and RF tuned circuits was quite poor. But even today, with much higher quality materials, double-spotting would still be a major problem using such a low IF.

Double-spotting (or more correctly, the "image") was a real annoyance and so designers set about solving this problem. As a result, triode valves were used for only a short time in superhets, being quickly replaced by the tetrodes and pentodes that were being developed during this time. The latter valve types had greater gain at RF compared to triodes and so generally didn't require neutralisation. And that in turn made it possible to select a higher IF to help overcome the image problem.

The next frequency selected was around 175kHz. This meant that the image frequency was now 350kHz (ie, 2 x 175kHz) away from the desired frequency (instead of being just 60kHz away). This meant that the image was rarely observed on those receivers that featured an RF stage – at least on the broadcast band.

However, if the receiver had no RF stage, it only had the selectivity of the aerial coil to rely on. Unfortunately, this was insufficient to provide image rejection and so the image was still quite evident – although further away. To overcome this problem, some sets used a bandpass double-tuned aerial coil network. However, this still involved using a 3-gang tuning capacitor, despite the absence of an RF amplifier stage.

A growing problem

In the 1920s, there weren't many radio stations and so the image didn't really present a problem. However, as the 1930s progressed, more and more radio stations commenced operation and they were becoming more powerful too. This meant that the gain of an RF stage was not needed on the broadcast band but due to the strength of many stations, the image problem was becoming quite noticeable again. This was particularly evident where stations were about 350kHz apart.

The move to a 455kHz IF

Fortunately, the materials used to make RF coils and transformers had improved during this period, as had the pentode valves used for RF amplification. As a result, a move to a higher intermediate frequency was investigated in the early to mid-1930s. This step also involved the Postmaster General's Department (PMG), as will soon be evident.

To overcome image problems, an IF in the frequency band just below the broadcast band was sought. However, the frequency band from 405-513kHz had been used by large ships and coastal radio stations since the beginning of the 20th century. This meant that the new IF had to be carefully selected, otherwise marine radio stations could break through into broadcast receivers on the IF frequency.

Obviously, having Morse code transmissions on top of the news or the current popular radio serial would not be well accepted. What's more, it would not be possible to tune the interference out.

The PMG allocated all frequencies for radio transmission services but had not allocated any marine frequencies around 455kHz. As a result, Australia fell into line with the USA which had already adopted 455kHz as the favoured IF frequency.

A number of manufacturers put a series tuned IF trap (455kHz) across the aerial and earth terminals to make doubly sure that interference problems would not occur. At the same time, the gain of the IF amplifiers increased as better low-loss materials became available for constructing IF transformers.

Initially, some IF stages used air-cored coils which were tuned by fixed and adjustable capacitors in parallel with one another. Later on, the capacitors were fixed and the inductance was varied by placing moveable iron-dust slugs into the centres of the coil formers. And later again, the two windings in most IF transformers were encased in an iron-dust or ferrite pot core type assembly which improved the performance even more.

With the IF at 455 kHz, the image was now 910kHz away. This meant

Photo Gallery: STC Model 5017A & STC Model 5017

The STC Model 5017A used the same chassis as the more compact 5017 shown at right but was housed in a different cabinet style. It featured an attractive illuminated dial that was oval in shape. The example shown here was produced in Sydney in 1936. It covered the medium-wave broadcast band only and used the following valve line-up: 6A7 frequency changer; 6D6 IF amplifier; 6B7 1st audio/detector/AVC amplifier; a 42 output stage; and an 80 rectifier. (Photo and information courtesy Historical Radio Society Of Australia).

Produced by STC (Sydney) in 1937, the Model 5017 was housed in a stylish wooden cabinet that was more upright than the cabinet used for the 5017A. It carried the same illuminated oval-shaped dial and also covered the medium-wave broadcast band. Its valve line-up was identical to that used in the 5017A, ie: 6A7 frequency changer; 6D6 IF amplifier; 6B7 1st audio/detector/AVC amplifier; a 42 output stage; and an 80 rectifier. (Photo and information courtesy Historical Radio Society Of Australia).

that a set tuned to 600kHz would have an image response at 1510kHz – nearly off the end of the broadcast band. The frequency difference had now become so great that the selectivity of a single tuned circuit in the aerial was adequate to reject almost all signals on the image frequency.

With the profusion of IF frequencies around 455kHz (445-475kHz), marine radio stations could be still amplified by the IF amplifier in those receivers not tuned to 455kHz. In Europe, for example, 465kHz and 475kHz were common IF frequencies, as the marine radio stations were allocated different frequencies to those used in Australia and New Zealand.

Substituting IF transformers

Anyone aiming to keep a supply of IF transformers to tune to every one of these frequencies is going to need a rather large box to store them all. Scrutiny of the range of frequencies will reveal that they fall into a few general frequency ranges such as 173-182.5kHz, 200-226kHz, 250-262.5kHz and 446-475kHz – with 390kHz, 550kHz and 595kHz being the odd ones out.

As an example, let's say that you have a set with an IF of 475kHz in which an IF transformer becomes faulty. So where can you get a replacement 475kHz IF transformer in Australia? The answer is you probably can't get one but fortunately, most 455kHz units can be adjusted to 475kHz.

In fact, most IF transformers have a frequency adjustment range of 110-115%. Therefore, it isn't necessary to keep a wide range of transformers. Most 175kHz transformers will cover from 173-182.5kHz and most 455kHz transformers will cover from 445-475kHz (these are the two most popular frequencies used). IF transformers in the 200kHz and 250kHz range were less common, with only a few receivers using them.

Modifying IF transformers

If a direct replacement can't be found, it's also possible to modify IF transformers to operate at different frequencies. Note, however, that their performance may be slightly inferior to the ideal replacement.

For example, I have an AWA AR8 receiver which has an IF of about 750kHz. One IF transformer winding went open circuit in the middle of the winding and replacements definitely are not readily available.

To solve this problem, I opened up an AWA 455kHz IF transformer of the same general size and reduced the value of the two fixed mica tuning capacitors (from 400pF to 100pF). This enabled the IF transformer to be tuned to 750kHz and the set worked just as well as it did with the original.

This is a useful trick to remember if you need to adjust an IF transformer to an odd-ball frequency that's outside its original tuning range.

Of course, new replacement IF transformers are no longer available but old derelict receivers are a good source. So never throw a derelict receiver away until you've stripped it of everything that's likely to be useful.

Standardised IF frequencies

In the domestic arena today, there are two main IF frequencies used on the AM bands: 455kHz and 450kHz. The latter is commonly used in synthesised receivers, since this frequency is very convenient where the set has

An early side-adjustment IF transformer, shown here out of its metal can. The holes in the side of the can provide access to the adjustment slugs.

to be able to tune in either 9kHz steps or 10kHz steps. That's because there are no complicated division ratios as there would be if 455kHz were used.

IF & detector radiation

During operation, all receivers radiate some signals from the IF amplifier and detector stages. These signals are radiated on 455kHz and also on the second harmonic at 910kHz. That's because the detector is a non-linear device and generates harmonics of the intermediate frequency.

For this reason, no radio station was allocated 910kHz when stations were 10kHz apart. Nor is 909kHz used now that 9kHz station spacing is used. If a station had been allocated 910kHz or 909kHz, there could have been considerable interference from the receiver itself and this would have caused "whistles" on that station.

As a matter of interest, I had an amateur-band receiver that tuned from 1800-1875kHz and it picked up the fourth harmonic radiation of the IF on 1820kHz. So it certainly can and does occur. A well-shielded radio receiver will radiate very little IF or IF harmonic energy but most domestic receivers are not shielded so these signals are radiated.

AM signal transmissions

As can be imagined, the signal emitted from AM broadcast transmitters determines the design parameters of IF amplifier stages. So let's take a closer look at AM broadcast signals.

The transmitted signal consists of three components: the carrier frequency (eg, 600kHz) plus upper and lower sidebands which convey the audio signal. These upper and lower sidebands are identical and they extend either side away from the carrier by an amount that's equal to the highest audio frequency used to modulate the transmitter.

For example, if there is a 10kHz audio frequency present, the sidebands are ±10kHz either side of the carrier frequency. This means that if the carrier is on 600kHz, for example, then the sidebands are at 590kHz and 610kHz, so that the whole signal is 20kHz wide. When that signal is converted to the IF, the actual receiver IF channel passband would need to pass all signals from 445kHz to 465kHz.

However, the IF amplifier passband shape is not perfect and signals are not amplified uniformly within the passband. In addition, the frequency response of the IF transformers does not drop dramatically outside of the wanted passband. Hence frequencies further than 10kHz from the centre frequency (455kHz) will also be amplified but to a lesser extent, as you can see from the IF response graph in Fig.1.

AM broadcast transmitters did transmit audio frequencies up to 10kHz and beyond before the introduction of 9kHz station spacing, although I suspect that they now restrict themselves to 9kHz. Shortwave AM radio transmitters such as Radio Australia only transmit audio frequencies as high as 4.5kHz.

For this reason, a 20kHz IF bandwidth is not always necessary. In the case of Radio Australia, for example, a 9kHz bandwidth would be quite adequate, particularly so when shortwave radio stations are allocated channels 5kHz apart. And although AM radio stations do transmit signals as high as 9kHz, very few run-of-the-mill receivers can reproduce frequencies that high.

The IF bandwidth of older receivers was probably of the order of 10kHz, which allowed frequencies up to 5kHz to pass through. However, the latest imported transistor sets may only have an IF bandwidth of just 7kHz which means that audio frequencies up to only about 3.5kHz will be reproduced. And that's not taking into account the limited response of the 50mm speakers used in many sets!

Why so many IFs?

According to the Australian Official Radio Service Manuals (AORSM) and other sources, 16 IF centre frequencies ranging between 445kHz and 475kHz were used. Many of these varied by just a kilohertz or so from an adjoining intermediate frequency.

It might be thought that manufacturers had some good reason why a particular IF centre frequency was used. However, with only a few exceptions, I can find no reason why this should be so. If a 455kHz IF channel is 20kHz wide, it would amplify all the frequencies/channels from

445kHz to 465kHz as mentioned at the beginning of the article, although not equally and with considerable sideband cutting and distortion in many cases.

In the 1930s and 1940s, many of the smaller manufacturers did not have accurate signal generators and may have relied on crystal oscillators to set the IF centre frequency. Crystals were not cheap so if they had one on a slightly different frequency to 455kHz, that would not have worried them. However, I do know why one frequency other than 455kHz was used in the days of 10kHz spacing between stations.

With a 455kHz IF, the image frequency is 910kHz higher. If a receiver was tuned to 600kHz (for example), the image would be on 1510 kHz. If there was a strong station on 1510 kHz and the station on 600kHz was weak, a whistle may have been heard on the weaker station due to the image response.

A clever scheme

To overcome this, HMV used an IF centre frequency of 457.5kHz. The image frequency in this case was 915kHz higher, so a receiver tuned to a 600kHz station would have an image frequency of 1515kHz, which is 5kHz away from the carrier frequency of broadcast stations on either 1510kHz or 1520kHz. This meant that, in an ideal world, the whistle was 5kHz and by adjusting the tone control it would not be evident.

This was a nifty idea by HMV and it worked quite well, provided that the IF was accurately aligned. And, of course, it also relied on the owner tuning the set accurately!

Next month we'll look at variable selectivity IF amplifiers, neutralisation, the effects of unintended IF radiation, problems with the AGC system and alignment. SC

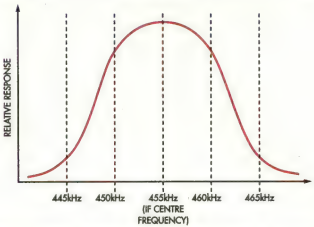

Fig.1: typical frequency response of an IF stage centred on 455kHz. Note that the response is not perfect since not all signals in the passband are amplified uniformly.

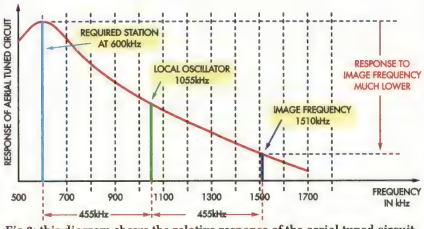

Fig.2: this diagram shows the relative response of the aerial tuned circuit to (1) a tuned radio station on 600kHz, (2) the local oscillator frequency on 1055kHz and (3) the image frequency at 1510kHz.

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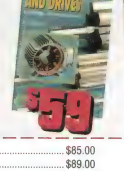

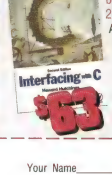

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Simple VHF FM/AM Regenerative Receiver

If you want to build an AM/FM radio it takes at least one special IC or quite a raft of discrete components, doesn't it? Wrong. As shown in this article, you can build a simple VHF receiver quite simply, particularly if it uses "slope detection" for the FM stations.

By ANDREW WOODFIELD

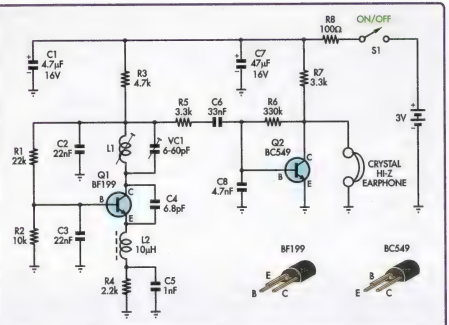
MANY READERS will remember building their very first radio. The projects that you built after this are probably a forgotten memory now but that first receiver, well, is often quite special. Perhaps, like many, it was a simple crystal set. In my case, I built a one-transistor reflex receiver, the parts bought with money earned from helping to paint a holiday beach house.

Tuning in those first sounds after hours of careful soldering, with the help of a long-suffering ham-radio-operator uncle, was nothing short of amazing for me. Then came an endless round of careful testing and adjusting of wire antennas and the earth connections to get the best performance out of that simple receiver. (I don't recall anything that made a real difference!)

It all made for a memorable summer, listening to music, news and cricket broadcasts on the AM band.

These days, most youngsters prefer listening to music and DJ chatter on the VHF FM band. Of course, you can buy an IC to build a radio but that hardly falls into the 'simple' category despite the modest number of parts required. Also, special ICs can be hard to find and expensive.

Making a simple FM radio receiver, at least at first glance, therefore appears far more appealing for someone



SC VHF FM/AM SUPER-REGENERATIVE RECEIVER

Fig.1: the circuit uses just two transistors. Q1 and its surrounding parts form a regenerative detector stage, with the receiver's frequency set by tuned circuit L1 and VC1. The output from this stage is fed to audio amplifier stage Q2.

Parts List

1 PC board, code 06212021, 37 x 31mm
1 battery holder for two AAA cells
2 x 1.5V AAA cells
1 crystal high impedance earphone
1 miniature slide switch
1 BF199 or equivalent RF small signal transistor (Q1)
1 BC549 or equivalent high gain small signal transistor (Q2)
1 10µH RF choke (L2)
L1: see text

Capacitors
1 47µF 16V PC electrolytic
1 4.7µF 16V PC electrolytic
1 33nF (.033µF) MKT polyester
2 22nF (.022µF) MKT polyester
1 4.7nF (.0047µF) MKT polyester or ceramic
1 6-60pF plastic trimmer capacitor
1 6.8pF 50V disc ceramic
2 1 nF 50V disc ceramic

Resistors (0.25W, 1%)
1 330kΩ 1 3.3kΩ
1 22kΩ 1 2.2kΩ
1 10kΩ 1 100Ω
1 4.7kΩ

Miscellaneous
Hookup wire, solder, case to hold PC board, etc.

just starting out in the hobby. However, designing a simple radio for FM which is truly repeatable is more of a challenge.

After all, FM cannot be received on a simple crystal detector, can it? (Actually, it can, but it's a complex and challenging construction project.) And there's no point in a design that won't go first time.

This article describes a simple FM radio that's inexpensive to build. It uses only a few more parts than a basic one-transistor AM radio or a crystal set, yet it can receive speech and music with reasonable quality from FM stations.

Based around a proven super-regenerative receiver design, it's also easy to build, and all of the parts are readily available. Finally, with a little adjustment, local VHF AM airport radio services can be received equally well.

Regenerative receivers

Regenerative receivers, of which this design is an example, are tuned amplifiers which are held right on the edge of oscillation. Any amplifier with too much feedback will oscillate - the loud squeal and howl of an audio amplifier with too much feedback is a memory we don't enjoy! In this case, however, the tuned amplifier's gain is allowed to rise until it just begins to start to oscillate.

The difference with a regenerative receiver is that as soon as it begins to oscillate, the circuit instantly reduces the amplifier's gain so that it drops out of oscillation again. With careful design, this type of tuned amplifier/oscillator can be made to fluctuate continuously in and out of oscillation, rapidly, right at this very high gain operating point.

There is considerable debate about the exact manner in which a regenerative receiver operates. Perhaps because this time-shared amplifier-oscillator action is inherently non-linear, such high-gain amplifiers readily detect amplitude modulation speech and music on received radio signals. The typical amplifier/oscillator quench frequency (as this on-off switching effect is called) varies between 10kHz and 100kHz.

In simple regenerative receivers, like this design, the quench frequency is not fixed precisely. It changes with component characteristics, temperature, supply voltage, as well as with external effects such as the presence of metal objects, or even as your hands get closer to the circuit. Regardless, the tuned amplifier is still kept on the edge of oscillation.

The quench rate is often controlled by a resistor and capacitor in simple regenerative receiver designs. Such components cannot reliably control all of the dynamics of a high-gain amplifier when large changes occur, of course. If the receiver is tuned over large ranges, for example, the amplifier may stop oscillating at some point, or it may begin to oscillate and never properly quench.

This is one reason why many simple regenerative receivers have a 'reaction' or 'feedback' control.

This allows precise adjustment of quench to keep the receiver as close as possible to the optimum setting. This design avoids this problem by selecting a compromise value for the resistor-capacitor pair and by limiting the

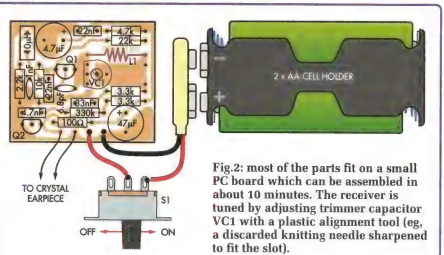


Fig.2: most of the parts fit on a small PC board which can be assembled in about 10 minutes. The receiver is tuned by adjusting trimmer capacitor VC1 with a plastic alignment tool (eg, a discarded knitting needle sharpened to fit the slot).

frequency range to the FM broadcast and nearby VHF aviation bands.

Circuit description

The receiver has two basic sections: (1) The regenerative detector, which amplifies and detects the signal; and (2) A simple one-transistor audio amplifier.

The full circuit is shown in Fig.1. Q1 and surrounding components form the regenerative detector stage. The receiver's frequency is set by the tuned circuit L1 and VC1. Capacitor C4 provides a path for RF feedback to encourage oscillation. The quench frequency is primarily set by R4 and C5 and as oscillation begins to rise, the increasing current through R4 ensures that Q1 is eventually limited, in turn halting oscillation.

As the regenerative receiver is tuned across a signal, the current through R3 varies with the modulation on the received signal. With amplitude modulated signals, such as those used by airports, the strength of the signal changes in sympathy with the audio signal. If the receiver is tuned to this signal, this variation in received signal level is detected and converted to small variations in collector current in Q1. In turn, this small signal is amplified by Q2.

The process by which this receiver detects FM is a little more complex. FM signals are generated when the audio signal changes the frequency of the transmitter rather than it's amplitude. When a very selective tuned circuit is adjusted closer and closer to the frequency of an FM signal, the amplitude of the received signal will increase. If the tuned circuit is sufficiently selective, the changing frequency caused by the modulation on the FM signal will cause an amplitude change in the signal across the tuned circuit.

This same effect was used in the earliest receivers to detect FM signals. The 'slope' of the tuned circuit's selectivity allowed this change in signal amplitude with changing frequency. This was called "slope detection". If you tune an FM signal using an AM receiver, the best sounding audio will be received when the FM centre frequency is offset from the centre frequency of the receiver's tuned circuits.

Since the receiver is rapidly turning on and off at the quench frequency, this gives rise to considerable hiss in the received audio, especially when not receiving a signal. This is a very characteristic sound in regenerative receivers. Since the quench frequency is so audible, R5 and C8 are used to reduce the level of this hiss.

C6 isolates the bias voltage on the audio stage around Q2 from the signal and bias voltages around Q1. Q2's bias is set using a very simple bias chain using two resistors; R6 and R7. This requires that Q2 be a high gain transistor but these are no more expensive than similar types and readily obtainable.

A crystal earphone in used to listen to the final detected sound. This minimises loading on the circuit, increasing the sound level considerably. It also saves a further amplification stage with another transistor, as well as the cost of a speaker and matching transformer.

The audio received with this arrangement is amazing. One of the prototypes produced music and sound that could be clearly heard more than a metre away from the receiver. For simplicity and to save considerable cost, there is no volume control on the receiver. We did say this receiver was simple, didn't we? If the audio level is too loud, R6 can be reduced to 220kΩ.

A further major advantage of this receiver design is its miserly battery drain. Prototypes averaged well under 1mA with a pair of AAA batteries, allowing for many hours of use. This is probably one of the most important considerations for younger builders (and parents!) keen to avoid the continual cost of battery replacement or expensive rechargeable cells.

Because the receiver oscillates mo-

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	100Ω	brown black brown brown	brown black black black brown

mentarily on each quench cycle, it is possible for the ultra-low microwatt oscillator signal to be detected in nearby conventional receivers. This was a major problem with 1930's valve versions of these receivers. These operated at many times greater power levels and the loud levels of radiated hash at the quench rate of the receiver could be heard in every nearby receiver - hardly a desirable characteristic!

Modern transistor equivalents, including this design, seldom encounter the same problem. In part, this is because they operate at much lower power levels. Instead of 90 to 150V DC power supplies required for a valve, this receiver makes do with just a sniff of current from a pair of AAA cells; ie, just 3V.

To further prevent this problem arising with this design, we've not made any provision for an external antenna. The receiver is highly sensitive and good reception can be achieved without any extra antenna. Also, attaching a short 1m long wire to the circuit is possible, say via a 4.7pF ceramic capacitor to the collector of Q1, it will shift the received frequency a little since it will partially load the tuned circuit, reducing the effectiveness of the detector.

Construction

The receiver can be built either using the PC board and housed in any convenient case. One of the prototypes was built into a small peppermint tin. (It's actually something of a little joke. The tin was a marketing giveaway from a manufacturer of one of the most advanced digital mobile radio systems currently produced. It somehow seemed appropriate to recycle it to house one of the oldest types of analog radio circuits.)

Begin construction by carefully inspecting the PC board for any unwanted short circuits between tracks or other manufacturing defects. Check for undrilled holes, too.

Mount all of the resistors and capacitors first. Then make and install the two coils, L1 and L2. L1 can be made by winding four turns of enamelled copper wire around a convenient 6mm diameter former. A drill bit or a pencil work well.

L2 is a small RF choke. If one cannot be found, you can make it by winding 30 turns of 36 gauge enamelled copper wire on a 1MΩ 0.25W resistor.

VC1 is miniature plastic trimmer capacitor which is used to tune the receiver to your favourite station. Insert it into the PC board carefully before soldering and don't use too much heat when soldering this into place. The plastic can melt if the trimmer gets too hot.

If you wish to only receive one station or you only want to tune a small range of frequencies, you could replace VC1 with a fixed capacitor. A 22pF ceramic capacitor works to cover the aviation band and 33pF can be used for the FM band. This may require some adjustment of coil L1, depending on the actual capacitor used to precisely tune into the signal you want. You may need to add or subtract a turn or two to L1 to allow the fixed capacitor to be used.

Install the two transistors next, making sure that the audio transistor (BC549) is used for Q2 and the RF transistor (BF199) for Q1. The receiver won't work if they are reversed.

Then add the wiring for the switch, the battery and the earphone.

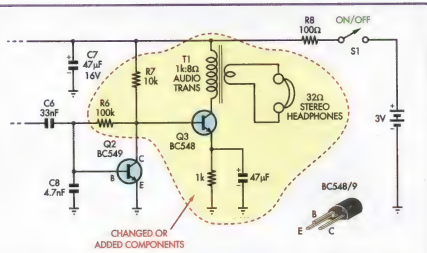


Fig.3: this diagram shows the extra parts that are required in order to use low-impedance stereo headphones (eg, from a portable CD player or a Walkman). This involves adding an extra audio stage based on transistor Q3 and a small audio transformer.

Earphone options

There are several earphone options. If possible, use a high impedance crystal earphone, although they can be hard to find in some locations. Most large parts suppliers almost always stock them.

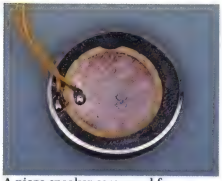
An alternative is to use a piezo speaker recovered from an old toy or from one of those greeting cards that plays a tune or a few pre-recorded words.

However, while these little speakers deliver lots of volume at high audio frequencies, they don't do so well at mid-to-low audio frequencies. How-

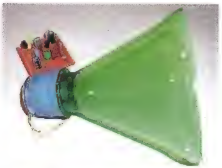
A small peppermint tin was used to house one of the author's early prototypes (and it wasn't even built on a PC board).

ever, you can add a simple horn to improve the sound quality somewhat. It can be made by cutting the top 100mm section from a plastic soft drink bottle. A hole around 8mm diameter was drilled into the cap and the piezo speaker was then hot-glued to the cap.

The resulting sound is not loud but it is clearly audible from a metre or more in a quiet room. Painted, it gave a 1930's look to one of the prototype receivers.



A piezo speaker scrounged from an old toy or from a greeting card can be used directly with the circuit shown in Fig.1.



A simple horn made by cutting the top 100mm section from a plastic soft drink bottle can be used to improve the sound quality of a piezo speaker (see text for details).

By the way, don't try to use a pair of stereo earphones from a Walkman. Their 32Ω impedance is much too low for this receiver. However, if you still would like to use these, then you'll need to add a small amplifier stage to the receiver and the current will rise substantially. The required components and changes to the receiver are shown in Fig.3.

Suitable transformers include Dick Smith or Altronics Part Number M-0216. If possible, connect the earphones so that the left and right earphones are in series. This helps increase the volume further. Fig.4 shows the earphone connections required.

Suitable transistors

RF transistors should be used for Q1, while audio transistors are suitable for Q2 and Q3, the latter being required if the stereo headphone modification is added. Suitable transistors include:

Q1: BF 115, BF184, BF199, BF494, MPSH11, 2N2222, etc (ie, RF transistors with h_{fe}>100 and f_T>250 MHz).

Q2: BC109, BC549, 2N3904 (ie, almost any high-gain small signal audio NPN transistor is likely to prove suitable).

A variety of these transistors were used on the three prototypes built, all working almost identically. The main difference was the current drain, with this varying between 0.6 and 1mA, depending on the RF transistor being used.

Testing and operation

Before proceeding further, carefully check the PC board again and the location and orientation of all parts. Check, especially carefully, the orientation of the two transistors. Are they in the correct location? Are all resistors in the correct location too? Check the underside of the PC board for poorly soldered joints or shorts caused by solder bridges where connections have been accidentally soldered too closely together.

Once you've checked the layout again, and with so few parts, testing is as simple as connecting the battery and switching on the power to the receiver. You should hear a loud hiss in the earphone. If that's the case, adjust the trimmer capacitor until you hear an FM station.

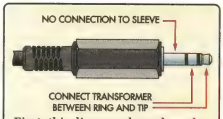


Fig.4: this diagram shows how the connections to a stereo headphone plug are made. Only the ring and tip terminals are used – there is no connection to the sleeve.

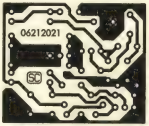


Fig.5: this is the full-size etching pattern for the PC board. Check your board for defects before installing any of the parts.

If you don't hear a signal, it's likely that the coil you've wound for L1 is a little too large. The simple solution is to, firstly, turn off the power to the receiver, then spread out the coil's turns. Spread the turns of the coil apart so that it occupies a length of, say, 12 or 15mm. Then, turn on the power again and try tuning again.

If you don't hear any hiss at all, turn off the power and recheck all your connections, especially those going to the earphone. You can check that the audio amplifier stage is working by pressing your finger lightly on the underside of the PC board with the power on (Don't worry - The battery voltage is high enough to be dangerous) and press on the base of Q2. You should hear a low hum if it's operating correctly. If you cannot hear anything, check the battery and the battery holder's connections carefully.

Tuning

Once you have the receiver operating, the receiver can be carefully tuned into your favourite station. This should be done with a plastic or insulated adjustment tool. An old plastic knitting needle or discarded piece of plastic rod from a kitset model plane works well. This minimises any frequency shift caused by the body as it gets close to the circuit. **SC**

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IR touch dimmer zapped by fluorescents

I've recently assembled the Touch Dimmer project from the January & February 2002 issues. It operates well but its behaviour is affected by the switching off of any fluorescent light in the house. Whenever a fluorescent light is switched off, it will switch off the light that's controlled by the dimmer or change to an oscillating mode where the light fluctuates between different levels of brightness.

Can you suggest a remedy. (A. C., via email).

● The problem is probably caused by interference from the fluorescent lights. The interference could be either conducted along the power lines or radiated directly from the fluorescent light to the infrared sensor in the touch light dimmer control.

To check where the problem lies, cover the infrared sensor dimmer with an opaque material so it cannot respond to light. If the dimmer is now not affected, then some shielding of the dimmer from the fluorescent lights may be necessary. Repositioning the dimmer in a darker or protected position may be required.

Alternatively, remove the infrared sensor (IC2) from the touch lamp dimmer and connect pin 9 of IC1 to pin 5. Check if the fluorescent lights now have an effect. If so, you may require better shielding, particularly from the house wiring. An earthed metal shield behind the dimmer unit may be sufficient to protect it. A .01µF 250VAC (Y class) capacitor connected between the Active and Neutral lines may also help with reducing interference.

Thirdly, the fluorescent lights themselves may need a power factor correction capacitor in each fitting. Have these installed by your electrician. The capacitor will act as a power line filter as well as correcting power factor.

You may also need to replace the starters in each fluorescent fitting as the suppression capacitor in these may have failed, particularly if the starters are old.

Dry cell rejuvenator

Will the dry-cell Battery Rejuvenator from the November 1994 of SILICON CHIP successfully charge "D" size cells? (J. C., Murray Bridge, SA).

● The circuit should work with D cells although charge time will be a lot longer. It takes around 18 hours to recharge an alkaline AA cell.

Substitute display for the MP3 jukebox

The MP3 Jukebox works great except that the display is very hard to see from five metres away. Would I be able to use the Moving Message Display (SILICON CHIP, February 1997) as a substitute for the MP3 Jukebox display? If so, what modifications will I need to do in order for this display to work with the MP3 JukeBox? (T. W., Girraween, NSW).

● Unfortunately, the Moving Message Display from the February 1997 issue is not compatible with the MP3 Jukebox. Both the hardware and firmware on the IR Remote PC board is designed to work with LCDs that are "HD44780" compatible, with 16 x 2 format. This limits the possibilities somewhat, unless you modify the microcontroller program.

You could try a "large character" LCD (with LED backlighting). Farnell stock a suitable item: Varitronix MDLS16268-C-LED04 (order code 301-3340). See:

http://www.varitronix.com/catalog/clm.html

This module has 4.84 x 9.22mm characters, which are almost twice as big as the standard modules. Note that you should keep the cable between the PC board and the LCD module as short as possible – no more than about 150mm, if possible.

Video monitor degaussing

One of the kids put a magnet to the computer screen and it has a green tinge. Can it be fixed? (B. M., via email).

● The shadow mask in your monitor has evidently become heavily magnetised, so much so that the normal inbuilt degaussing coil may not be capable of fully curing it. You could

Low fuel warning indicator

Is it possible to modify the Low Fuel Warning Indicator kit (SILICON CHIP, February 1993) so that it can be used as a warning light for low oil pressure instead?

The circuit works in conjunction with the fuel sender in the tank and you set the parameters relative to where the gauge is registering, so I was wondering if it was possible to remove the components that create the 10-second delay and use it as a low oil pressure warning light instead. Also would it be versatile enough so that you can select a relatively high oil pressure, say around 20-30 psi? I wouldn't care if it glowed at idle when the oil was hot.

I ask this because cars that come with inbuilt gauges on the dash as standard never have an indicator light as well. (B. S., via email).

● The low fuel indicator can be used for other measurements. The 10kΩ resistor in series with VR1 can be reduced in value if the range is not sufficient. The delay may be reduced but it may still be necessary to have a small delay to prevent false triggering. Use a 10µF capacitor instead of the original 220µF delay capacitor.

IR transceiver is possibly damaged

I bought the kit to make the IR transceiver published in the December 2001 issue. I tried it out on my Win2000 and it didn't detect it automatically, so I tried to configure it manually and it still didn't work. The circuit has been checked out OK and I would like to know what needs to be done now to get it working.

I have enabled IR in BIOS and it is set as IrDa and the Tx Rx stuff is Hi Lo respectively. I don't know if that makes any sense. From your documentation and the stuff I have seen on websites, it should be detected automatically.

I downloaded something from Microsoft called IRCOMM, as it was a patch 2000 apparently needed. Currently, I have Service Pack 2 installed and some pre-Service Pack 3 fixes. Your help would be greatly appreciated. (A. M., via email).

● You should be able to verify that the IR LED inside the TFDS4500 module is not damaged by using your DMM. Switch your DMM to "Diode Test" and measure between pins 1 & 8 of the TFDS4500. With the positive DMM probe on pin 8 and negative probe on pin 1, you should get a reading of about 1.23V. Reverse the leads and you should get no reading (high resistance).

You should refer to the "Mailbag" pages in the May 2002 issue for additional information about motherboard BIOS settings. Microsoft provide the following general info about irDA setup on Win 2000: How To Configure Your Computer for Infrared Communication in Windows 2000 (Q302011). See: **http://support.microsoft.com/search/preview.aspx?scid=kb;en-us;Q302011**

try turning it on and off several times, leaving at least five minutes between. If that doesn't work you will need to take it to your local serviceman to be degaussed.

Battery load tester

Has there been a project or article written regarding load testing a car battery or other heavy duty batteries? I have need for a device for testing the condition of heavy duty batteries. Even if a project may not be viable, the methodology for load testing a battery, statistics and figures may be an interesting topic for some.

I was prompted for such a device after my car battery of 18 months began to intermittently fail to crank the engine. The NRMA technician, who attended after I eventually determined the battery to be at fault, confirmed my view of a defective battery with a load testing device. I also have a need for a device in the rail preservation scene, with many batteries of unknown quality needing a basic Go/No-go test to determine their future. (R. P., Cowra, NSW).

● Car battery load testing is usually done with a "carbon pile". Auto-electricians have them. Generally though, you can do a rough and ready test by just turning on all lights; ie, low beam + high beam. A marked drop at the battery terminals indicates a real problem. Testing large storage batteries is more problematic and needs to be done at specified load conditions for the particular battery.

Crossfire problem in multi-spark ignition

I built myself a Multi-Spark Ignition System, (SILICON CHIP, September 1997). It went into a 1977 Fairlane V8 and I used the Hall Effect pickup. The car runs well on idling but as soon as I try to accelerate, the ignition breaks down; the engine sounds as if it is running on two cylinders.

I looked for crossfire but did not notice any. I would appreciate it very much if you could tell me what the problem might be. (U. S., via email).

● Since the engine is a V8, there is always a strong likelihood of crossfire, particularly when the engine is under load.

Try reducing the number of multi sparks with the capacitor, as detailed in the article. If this does not help, change the operation to single spark. If it is still misfires, it probably does have crossfiring and all the ignition leads will need to be separated widely to prevent this.

Higher speed setting for PC infrared transceiver

Having recently built the PC Infrared Transceiver from the December 2001 issue, I was wondering what is involved in taking the unit's speed from SIR (115.2kbps), the default setting, to the next higher speed of MIR (1.152Mbps)?

Is it a matter of changing external components or is it permanently set by the TFDS4500 transceiver module internals?

I realise that this speed was chosen to support all types of Pentium motherboard and the unit works well, but a change in speed would be very welcome as I have a motherboard that supports the higher IR transmission rates. (B. C., via email).

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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● Unfortunately, the maximum rate is determined by the TFDS4500 module, which you correctly state at 115.2kbps.

We may publish something faster in the future (MIR and/or FIR) but we can't give any guarantees. If you're keen to upgrade soon, you might consider a commercial solution.

Microgram Computers often advertise IR add-ons – check them out at www.mgram.com.au

Ammeter has stopped working

I recently constructed the 80A Automotive Ammeter from the June 2002 issue and it was working well. However, it now fails to give any correct indication of current levels.

When I attempted to re-calibrate the unit at the 'zero' current level, the 'CAL' LEDs light but on removal of the shorting plug, the indication goes to 'OL'. Attempts to calibrate at other levels bring either totally erroneous (high) readings or the 'OL' indication again.

The ammeter is an important part of my domestic solar system. I gather it should work satisfactorily in this situation? (R. T., Darbys Falls, NSW).

● Perhaps there is a short in the Hall effect wiring or the Hall sensor is not working. Check that the Hall effect unit is receiving its 5V supply and that its output is around 2.5V.

Alternatively, there may be a problem with the LM358 and associated components. Check its supply and that the output is a varying voltage, indicating that the conversion process is working.

Operating the turbo timer from 24V

Is it possible to operate the turbo timer (SILICON CHIP, November 1998) on 24V DC. If so, what mods do I need to make? (G. S., via email).

● It is possible to operate the turbo timer from 24V. Change the 33Ω resistor to ZD1 to a 680Ω 1 W resistor and change ZD1 to a 15V 1 W zener. Also, change the 10kΩ resistor connecting between ground and the 1.8kΩ resistor to 1kΩ.

Also the relays will need a series resistor with the 12V relay coil to limit the voltage across their coils. Measure the coil resistance in ohms and use a 5W resistor of the same value in series with the coils. SC

Notes & Errata

Whistle & Point Cable Tracer, October 2002: the pinout diagram for the C8050 package (circuit, page 54) is incorrect. The C8050 collector & emitter pins are reversed with respect to common general-purpose TO-92 transistors like the BC549.

5A Speed Control, October 2002: the 100nF capacitor shown on the PC board diagram on page 17 should be 47nF to agree with the circuit on the same page.

Note also that the pinout diagram for the MCR100 on the circuit is wrong with regard to the Anode and Gate pins. The gate is the centre pin of the package as it is with the C103B however the A and K pins are swapped.

40W Fluorescent Inverter, September 2002: due to tolerance variations within the L6574 (IC3), it is recommended that the maximum current delivered to the fluorescent tube be adjusted using a trimpot. The 100kΩ resistor connecting between pin 2 of IC3 and the top of the dimming potentiometer (VR1) should be replaced with a 50kΩ trimpot and series 82kΩ resistor. The 1.2Ω resistor between the source of Q4 and ground should be changed to 2.2Ω to allow the full dimming range available from VR1.

Using the current measuring setup of Fig.8, the trimpot should be adjusted for the 370mV, corresponding to 3.7A when the dimming pot (VR1) is turned fully clockwise. Note that this adjustment should be made after the inverter has been running for some time and is fully warmed up. Once adjusted, the trimpot and 82kΩ resistor can be swapped for a single resistor that is the same value as the total series combination.

When testing the current (using the setup of Fig.8), it is important not to have the 0.1Ω 5W resistor in series with the supply for any appreciable length of time as the current drawn will begin to increase. To prevent this, short out the 0.1Ω resistor (with a clip lead) when not making the measurement. Remove the clip lead briefly to make the current measurement.

In addition, use heavy gauge wire rated at 7.5A or more to connect the inverter to the 12V battery.

The lower cost MTP3055E Mosfets can be substituted for the STP-60NE06 devices used for Q1 and Q2.

The Dick Smith Electronics D-5375 ferrite core is also suitable for L2 and requires 100 turns of wire (50 turns on each half) instead of the 84 total shown in Fig.6.

4-Channel UHF Remote Control, July 2002: the circuit diagram on page 20 is incorrect. On the PC board overlay diagram, the collectors of all four transistors (Q1-Q4) connect first to 2.2kΩ resistors, then to their respective LEDs. However, the resistors and LEDs are swapped on the circuit diagram.

MP3 Jukebox, September/October 2001: since publication of this project, version 2 of the Winamp software has been superseded by version 3. Unfortunately, Winamp version 3 is not suitable for use with the MP3 Jukebox. However, the last release of version 2 (v2.8.1) can be downloaded from **http://classic.winamp.com** SC

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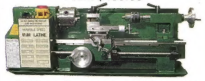

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Advertising Index

Acetronics 95
Altronics ..... loose insert
Av-Comm Pty Ltd 95
Clarke & Severn 59
Dick Smith Electronics 14-17
Elan Audio 79
Emona 43
Grantronics 94
Harbuch Electronics 31
Instant PCBs 95
Hy-Q International 59
Jaycar 45-52,95
JED Microprocessors 5,59
MicroByte Electronics 59
Microgram Computers 3
MicroZed Computers 59,95
MobAcc 96
Oatley Electronics ..... IFC
Printed Electronics 95
Procon Technology 59
Procopy 59
Quest Electronics 89
RCS Radio 96
RF Probes 93
Silicon Chip Binders 39
Silicon Chip Bookshop 84-85
Silicon Chip TestBench ..... IBC
Silvertone Electronics 59,96
Soundlabs Group 59
Splat Controls 57
Taig Machinery 96
Telelink Communications ... 59,OBC
Wiltronics 59

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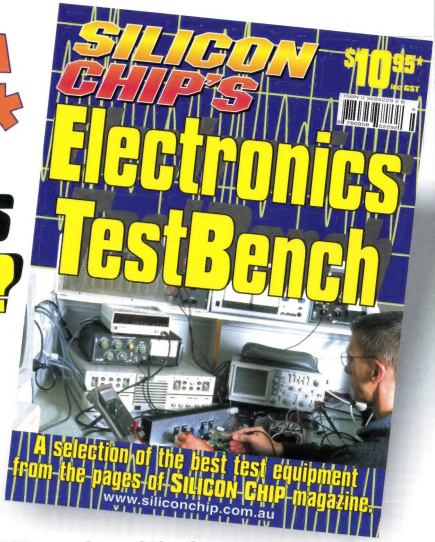

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